Volume 42 Number 4 2015

The Australian Mathematical Society

Gazette

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The *Gazette* publishes items of the following types:

- Reviews of books, particularly by Australian authors, or books of wide interest
- Classroom notes on presenting mathematics in an elegant way
- Items relevant to mathematics education
- Letters on relevant topical issues
- Information on conferences, particularly those held in Australasia and the region
- Information on recent major mathematical achievements
- Reports on the business and activities of the Society
- Staff changes and visitors in mathematics departments
- News of members of the Australian Mathematical Society

Local correspondents submit news items and act as local Society representatives. Material for publication and editorial correspondence should be submitted to the editors. Any communications with the editors that are not intended for publication must be clearly identified as such.

Notes for contributors

Please send contributions to gazette@austms.org.au. Submissions should be fairly short, easy to read and of interest to a wide range of readers.

Please typeset technical articles using LaTeX or variants. In exceptional cases other editable electronic formats such as plain text or Word may be accepted. Please do not use definitions in your TeX files, as they may conflict with our style files. If you find such definitions convenient, please use a text editor to reinstate the standard commands before sending your submission.

Please supply diagrams as vector images (not bitmaps) where possible, as postscript (.ps) or encapsulated (.eps) files. Please supply photos at high-resolution (i.e. at least 400 pixels per inch (16 pixels per mm) at the final size of reproduction. For example, if the image is to be printed at 90 mm wide, it must be at least 1400 pixels wide. If JPEG format is used, images must be created with a high quality factor, i.e. artefacts such as halos of dots or jagged edges should not be obtrusive at high magnification. For more information, see *An Introduction to Computer Images* at delta-intkey.com/www/images.htm.

More information can be obtained from the *Gazette* website.

Deadlines for submissions to 42(5), 43(1) and 43(2) of the *Gazette* are 1 October 2015, 1 February 2016 and 1 April 2016.

Volume 42 Number 4 2015

Editorial

Sid and I welcome you to another issue of the *Gazette*. Let me start with two exciting recent developments.

First, at the International Mathematics Olympiad in July, the Australian team had its best ever performance, showing that the best of our secondary students are very good indeed. Alexander Gunning, from Melbourne, scored a gold medal for the third time, and Seyoon Ragavan, from Sydney, also won a gold medal. The other four team members all won silver medals. Our congratulations to all of them!

Second, a research institute to be known as MATRIX is being established at the University of Melbourne. Rather like Oberwolfach, the MSRI in Berkeley, the Isaac Newton Institute, the Banff International Research Station, and the Institute for Mathematics and its Applications, it aims to have regular residential research programs. We look forward to further news about its development.

As reported previously, Ken Pearson of LaTrobe University passed away in May. We publish an obituary in this issue. It tells the interesting story not only of his contributions to innovative teaching and university administration, but also of his research transition from topological semirings to large systems of sparse linear equations to economic modelling. For his contributions to economics, he was elected a Fellow of the Australian Academy of Social Sciences.

The discovery of links between apparently distant branches of mathematics, and of real world applications of curiosity driven research, is something we are all aware of. We have remarked before on the contribution of mathematical and physical sciences to the national economy. This brings us back to the perennial issue of the state of mathematics education, a topic addressed by several columns in this issue.

In August, AMSI released its fourth annual Discipline Profile of the Mathematical Sciences. This document raises serious concerns about the state of secondary, tertiary and post-graduate mathematics education, including the low level of female participation, and the long term economic consequences of this reduction in the nation's skill base. Geoff Prince discusses these at length in his column.

One recent response by Society members is the formation of the Special Interest Group in Mathematics Education. Deborah King and Joann Cattlin discuss major issues in undergraduate mathematics education, such as the wide diversity in student ability, pressures to update teaching methods, and the increasing need to document learning outcomes. Against this background, they report on the objectives and activities of SIGME, whose first meeting took place in Adelaide in September (after the submission of their article).

The role of our honours programs is carefully considered by Tim Marchant in the President's Column. Tim argues that they have not been successful as a research training pathway and that alternatives need to be examined to invigorate research training.

Even the Australian Government has concerns: the Mathematics by Inquiry Request for Tender (which closed recently) called for tenders to develop, disseminate and ensure widespread awareness and uptake of a suite of mathematics teaching and learning resources for Foundation to Year 10. Nalini Joshi examines this in some detail in her column, and asks you to reflect on whether it will resolve the troublesome issues mentioned above. We extend our congratulations to Nalini on becoming one of the 100 Women of Influence listed in the The Australian Financial Review last month.

Returning to good news, we extend our congratulations also to Cheryl Praeger, for three honours she received in August; to Melissa Lee, Ioannis Tsartsaflis, Anna Tomskova, Matthew Tam and Philipp Bader, for their participation in the Heidelberg Laureate Forum in August. Brief reports on all of these appear in this issue.

This issue contains another report on a conference supported by AustMS and AMSI; several more will appear in the next issue.

Other regular features are three book reviews, the report from the AustMS secretary and the ever-entertaining Puzzle Corner. We hope you will find some thought provoking reading here.

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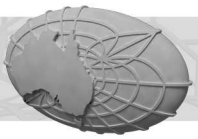
David Yost is a graduate of the University of Melbourne, the Australian National University and the University of Edinburgh. He has lived in eight countries and ten cities, returning to Australia in 2003, where he has now completed twelve years at Federation University Australia and its predecessor institution, the University of Ballarat, including a three-year period as Deputy Head of School. While most of his research is in functional analysis, he has lately been interested in convex geometry.



President's Column

Tim Marchant*

The Federal Government has recently commissioned the Australian Council of Learned Academies to undertake a review of Australia's research training system. So it's timely to consider the performance of the mathematical sciences in training research students at the doctoral and masters by research level. Peter Johnson from Griffith University reports annually on research and Honours degree completions in the mathematical sciences at Australian universities. His data shows a total of 170 Honours and 100 PhD completions in 2013. The current level of Honours completions is about the same as that in the 1970s while PhD completions have doubled since the mid-1990s, presumably due to increased numbers of international students. As a point of comparison the total number of university completions in Australia has doubled since 2000. So the performance of Honours in the mathematical sciences, as a research training pathway degree, has been extremely poor and its future should be seriously questioned.

The research training review discussion paper canvasses a number of important issues such as alternative research training pathway degrees, skills development for industry careers and better and more consistent funding models. The Chair of the review panel, Mr John McGagh, discusses a number of these issues in The Australian (5/8/15), including the idea of funding based on completion rates and times, rather than the volume of completions.

What should Society members do to invigorate research training in the mathematical sciences? I think alternative pathway degrees need to be more widely offered; for example both Macquarie University and Western Sydney University have recently replaced Honours by a two-year Research Masters Degree. We also need to do more to build links with international partner universities, which will attract additional research student candidates to Australia. In terms of post-graduate employment, developing industry experience and skills is also vital for many students. AMSI Intern and the ATN Doctoral Training Centre represent successful initiatives to build industry skills but more links and interactions are needed between industry and research students in the mathematical sciences.

John Loxton, Editor of the Bulletin of the AustMS, has contacted me in response to the comment in my previous Gazette column that the focus of the Bulletin is pure mathematics. He points out that the Bulletin aims at quick publication of original research in all branches of mathematics and he would like to publish more papers with an applied focus and on modern applications to finance, security, ecology, statistics etc. I support his sentiments and encourage our members, from all areas of the mathematical sciences, to submit their work to the Bulletin.

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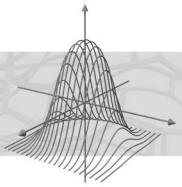
I would like to congratulate our three Society members who recently won ARC Laureate Fellowships; they are Professors Ben Andrews, Kerrie Mengersen and Trevor McDougall. These prestigious awards represent the pinnacle of research achievement in Australia and build on great success in the Laureate and Federation fellowship schemes for Society members in the last few years. This record illustrates the quality of research our members undertake and bodes well for the future.

Tim Marchant received his Doctorate from Adelaide University in 1989. After graduation he joined Wollongong University where he is currently Dean of Research and Professor of Applied Mathematics. His research areas include nonlinear optics, nonlinear waves and combustion theory. Tim is a Fellow of the Australian Mathematical Society, a Member of the Endeavour Awards selection panel and on the editorial board of *Applied Mathematical Modelling*. His other interests include playing bridge and learning Mandarin.



Puzzle Corner

Ivan Guo*

Welcome to the Australian Mathematical Society *Gazette*'s Puzzle Corner number 44. Each puzzle corner includes a handful of fun, yet intriguing, puzzles for adventurous readers to try. They cover a range of difficulties, come from a variety of topics, and require a minimum of mathematical prerequisites for their solution. Should you happen to be ingenious enough to solve one of them, then you should send your solution to us.

For each puzzle corner, the reader with the best submission will receive a book voucher to the value of $50, not to mention fame, glory and unlimited bragging rights! Entries are judged on the following criteria, in decreasing order of importance: accuracy, elegance, difficulty, and the number of correct solutions submitted. Please note that the judge's decision — that is, my decision — is absolutely final. Please email solutions to ivanguo1986@gmail.com or send paper entries to: Gazette of the Australian Mathematical Society, Faculty of Science and Technology, Federation University Australia, PO Box 663, Ballarat, Victoria 3353, Australia.

The deadline for submission of solutions for Puzzle Corner 44 is 15 November 2015. The solutions to Puzzle Corner 43 will appear in a future issue of the *Gazette*.

Notice: If you have heard of, read, or created any interesting mathematical puzzles that you feel are worthy of being included in the Puzzle Corner, I would love to hear from you! They don't have to be difficult or sophisticated. Your submissions may very well be featured in a future Puzzle Corner, testing the wits of other avid readers.

Triangular territory

Consider a finite set of points in the plane. Suppose that the area of the triangle formed by any three points is at most 1. Prove that the entire set of points must lie in a triangle whose area is at most 4.

Perpendicular cuts

Let an *irregular pizza* be a region in the plane which is closed, bounded and has a well-defined area. Prove that every irregular pizza can be cut into four pieces of equal area using two straight and mutually perpendicular cuts.

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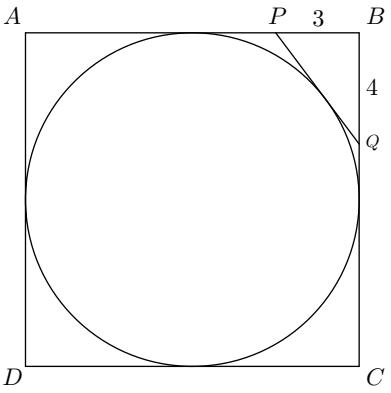
Inscribed radius

Let $ABCD$ be a square with an inscribed circle. Let P and Q be points on sides AB and BC, respectively, such that PQ is tangent to the circle. If $PB = 3$ and $QB = 4$, what is the radius of the circle?



Friendly division

Any two people are either friends or not friends. Given a group of people, is it always possible to divide them into two groups such that for any person, at least half of his/her friends are in the opposite group?

Squaring off

(i) Amy and Bob are playing a game on an unmarked $n \times n$ chessboard. Amy begins by marking a corner square. Then Bob marks an unmarked square which is adjacent to (sharing an edge with) the square Amy just marked. Then Amy marks an unmarked square which is adjacent to the square Bob just marked. Then it is Bob's turn again and so on. This process continues until one of them can no longer make a valid move and loses the game. Who has a winning strategy?

(ii) If Amy's first move is to mark a square adjacent to a corner square, who has the winning strategy?

Solutions to Puzzle Corner 42

Many thanks to everyone who submitted. The $50 book voucher for the best submission to Puzzle Corner 42 is awarded to Kevin McAvaney. Congratulations!

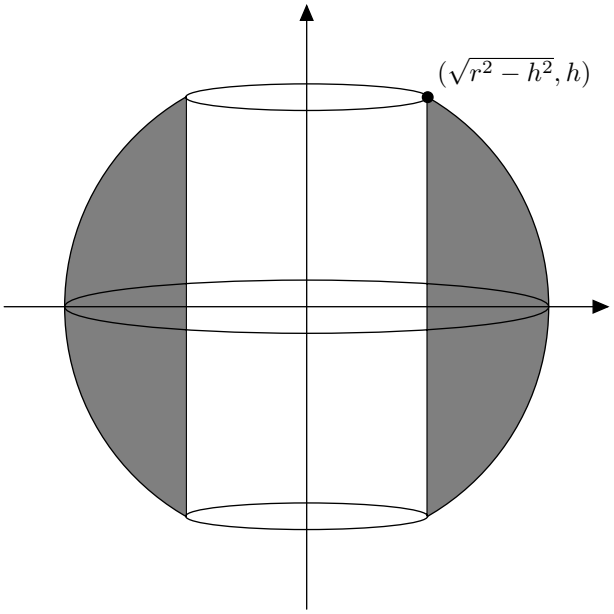
Volume valuation

A spherical ball has a cylindrical hole drilled through its centre. Prove that the remaining volume only depends on the length of the cylindrical hole.

Solution by Steve Clarke: Let the sphere have radius r and let the length of the cylindrical hole be $2h$. Then the radius of the hole is $\sqrt{r^2-h^2}$. The remaining volume can now be computed using the following integral:

$$2\int_{\sqrt{r^2-h^2}}^{r} 2\pi x\sqrt{r^2-x^2}\,\mathrm{d}x = -\frac{4\pi}{3}[(r^2-x^2)^{3/2}]_{\sqrt{r^2-h^2}}^{r} = \frac{4\pi h^3}{3}.$$

Thus the remaining volume only depends on h.



Random subsets

Let S be a set with n elements. Sammy randomly chooses a subset of S. Sally also randomly chooses a subset of S. What is the probability of Sammy's set being a subset of Sally's set?

Solution by Jensen Lai: Instead of choosing a random subset of S, it is equivalent to independently choose each element with a probability of $1/2$. Let us fix any particular element $a \in S$. There are four equally likely possibilities regarding who chooses a:

both, neither, only Sally, only Sammy.

Call the element *a good* if one of the first three possibilities occurs. It is clear that in order for Sammy's set to be a subset of Sally's set, a must be good. The probability of a being good is $3/4$.

Since the required subset condition holds if and only if every element is good, and the elements are chosen independently, the required probability must be $(3/4)^n$.

Musical musing

Six musicians are attending a music festival. At each scheduled concert, some of them may perform while the others listen as members of the audience. How many such concerts are needed so that every musician has a chance to listen, as a member of the audience, to every other musician?

Solution by Kevin McAvaney: Four concerts are needed to fulfil the requirements. A schedule of the concerts must include all possible ordered pairs (a, p) of musicians, where a is the audience while p is playing. There are $6 \times 5 = 30$ such ordered pairs.

In any concert, if exactly m musicians are playing, the number of ordered pairs covered is $m(6 - m)$. This is maximised if $m = 3$ and $m(6 - m) = 9$. Hence three concerts can cover at most $3 \times 9 = 27$ ordered pairs. This is insufficient since we require 30 ordered pairs.

To show that four concerts are sufficient, number the musicians 1 to 6 and use the following construction.

Performers	456	235	136	124
Audience	123	146	245	356

It is easy to check that every ordered pair is covered by this construction.

Repeated rummage

There are $n + 1$ cards, each having a number between 1 and n. You know that every number between 1 and n appears exactly once, except for one number which appears twice. The cards are placed in a row, face down on the table. Furthermore you know that they are sorted in ascending order from left to right. How many cards do you need to turn over in order to determine the repeating number?

Solution by Dave Johnson: Let $f(n)$ be the minimum number of flips for $n + 1$ cards. Note that the leftmost card is always 1 and the rightmost card is always n, whereas the ith card from the left $(1 < i < n)$ can be either $i - 1$ or i. We will prove a few facts about $f(n)$.

First of all, $f(n)$ is non-decreasing, or $f(n) \leq f(n+1)$. To show this, suppose there are only $n+1$ cards to begin with. We can simply add an additional card labelled $n+1$ on the right, then apply the algorithm for $n+2$ cards to find the repeating number in $f(n+1)$ flips. Therefore $f(n)$, the number of flips required for $n+1$ cards, is at most $f(n+1)$.

Next, $f(2^k) \leq k$. Consider the case where there are 2^k+1 cards. Let us first flip over the middle card. There are two cases. If the middle card is 2^{k-1}, then the repeating number must be in the range $[1, 2^{k-1}]$. If the middle card is $2^{k-1}+1$, then the repeating number must be in the range $[2^{k-1}+1, 2^k]$. In both cases, the problem is now equivalent to determining the minimum number of flips required for $2^{k-1}+1$ cards (including the middle card), or $f(2^{k-1})$. Repeating this argument $k-1$ times, we are left with only 3 cards, which can be resolved using only 1 flip. Therefore $f(2^k) \leq k$ is proven.

Finally, $f(2^k+1) \geq k+1$. For the sake of contradiction, suppose that only k flips are needed for 2^k+2 cards. In particular, the repeating number can take 2^k+1 possible values. But since each flip has at most two possible outcomes, we cannot distinguish between more than 2^k scenarios. This is a contradiction.

Combining everything, i.e. $f(n)$ is non-decreasing, $f(2^k) \leq k$ and $f(2^k+1) \geq k+1$, it is clear that the unique function satisfying all the requirements is $f(n) = \lceil \log_2 n \rceil$. Therefore the minimum number of flips required to identify the repeating number is $\lceil \log_2 n \rceil$.

Suitable suitor

A king is choosing a bridegroom for his daughter. There are three suitors available, a knight, a knave and a commoner. The king knows that the knight always tells the truth, the knave always lies and the commoner can do either. The king would like to avoid choosing the commoner, but he does not know who is who.

(i) *Suppose the three men do not know each other. If the king can ask each man a yes/no question, what should he ask to find a suitable bridegroom?*

(ii) *Suppose the three men know each other. If the king can only ask one man a single yes/no question, what should he ask to find a suitable bridegroom?*

Solution by Aaron Hassan: (i) The king can ask each suitor a question which is always true (e.g. 'Does $1+1=2$ hold?'). The knight will answer 'yes', the knave will answer 'no'. The commoner will agree with exactly one of them. To choose the bridegroom, the king can simply choose the person who answered differently to the other two. This method will always avoid the commoner.

(ii) The king can arrange the three suitors in a horizontal line. For convenience let us label them A, B and C from left to right. He could then ask A the following question: 'From my perspective, is the knave standing directly (i.e. adjacent) to the left of the commoner?' If the answer is 'yes', then B should be chosen. If the answer is 'no', then C should be chosen.

To show that this method works as intended, let us consider the possible cases.

- If A is the knight, then the answer is truthful. 'Yes' implies B is the knave, while 'no' implies B is the commoner. The knave is chosen as the bridegroom.
- If A is the knave, then the answer is a lie. 'Yes' implies B is the knight, while 'no' implies B is the commoner. The knight is chosen as the bridegroom.
- If A is the commoner, then the commoner is always avoided since A is not chosen regardless of the reply.

Therefore this method always avoids choosing the commoner as the bridegroom.

Ivan is a Postdoctoral Research Associate in the School of Mathematics and Applied Statistics at The University of Wollongong. His research involves financial modelling and stochastic games. Ivan spends much of his spare time pondering over puzzles of all flavours, as well as Olympiad Mathematics.

Honours for Cheryl Praeger

Professor Cheryl Praeger AM FAA of the University of Western Australia received three honours in August.

WA Science Hall of Fame

Following her induction into the WA Women's Hall of Fame in March, Cheryl Praeger has now been inducted into the WA Science Hall of Fame. This was one of several Science Awards announced by the WA Government at the 2015 Premier's Science Awards ceremony on 20 August.

Details of all the awards this year are at https://www.mediastatements.wa.gov.au/Pages/Barnett/2015/08/Premier-congratulates-Science-Award-winners.aspx and a list of all inductees into the WA Science Hall of Fame at http://www.research.uwa.edu.au/fellows/wa-science-hall-of-fame.

Dr. Mehdi Behzad's Award

Cheryl Praeger has been awarded the Dr. Mehdi Behzad's Award. This annual multinational award was established by the Iranian Mathematical Society, in honour of the Graph Theorist Mehdi Behzad, for individuals with outstanding leadership role in advancement of mathematics in their respective countries.

Honorary Doctorate from Yazd University

Cheryl Praeger was also awarded an honorary doctorate from Yazd University. Visit https://www.yazd.ac.ir/schools/mathematics/news/i/10175 for details and photos from the award ceremony.

Mathematics Education Special Interest Group

Deborah King* and Joann Cattlin**

In 2015 a new special interest group of AustMS was formed. The Special Interest Group in Mathematics Education (SIGME) has been established to provide Society members with an opportunity to share ideas and innovations that will enhance the quality of their teaching. It will also enable national collaborative research into university level mathematics education. We have seen, in recent years, increased interest amongst mathematicians in mathematics education, with record numbers of presentations (27) submitted to last year's ANZMC8 Conference and steady growth in mathematics presentations at the annual Australian Conference of Science and Mathematics Education. There has also been strong interest nationally in research projects in mathematics education, such as FYiMaths and Mathassess[1]. SIGME will provide a forum for AustMS members to contribute to, and be informed of, the current national discussions in university mathematics education.

Growing interest in undergraduate mathematics education

As universities increase their student intake, the diversity in student ability increases, posing challenges for effective teaching. Many institutions are finding that first-year students are disengaged and lack confidence, with consequent high failure rates and student attrition (Coupland, Stanley, Groen, Bush and Beames (2013); Rylands and Coady (2009)). While the reasons for this will vary across institutions, it is generally acknowledged that students often do not have the required background in mathematics to succeed in their chosen courses (King and Cattlin (2015)).

Mathematicians are also under pressure to develop new approaches to teaching to meet institutional initiatives in online learning, new teaching technologies and supporting student engagement, such as blended learning, flipped classrooms and online assessment. This can be a daunting and time consuming task, particularly when these innovations are difficult to adapt to the discipline specific challenges of mathematics (such as large student cohorts, dense curriculum and high level of abstraction). In recent fora, mathematicians have found that networking with

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[1]The FYiMaths (www.fyimaths.org.au) and Mathsassess (www.mathsassess.org) projects were funded by the Australian Government Office for Learning and Teaching (OLT) from 2012–2014. They involved over 300 mathematicians and mathematics educators in workshops and seminars across Australia. These projects identified a wide range of approaches to undergraduate mathematics education and in particular the many adaptations to curriculum and teaching that are underway to address student diversity.

colleagues from across the country provides access to invaluable practical advice and current research to inform their practice.

Academics are keenly aware that in the new regulatory framework universities must meet academic standards for teaching and learning. These include requirements for students to graduate with particular learning outcomes. These measures often necessitate curricula and assessment review to ensure that content and learning outcomes are aligned and that assessment verifies that the outcomes have been achieved. Connecting with colleagues from other institutions provides opportunities to share experiences, to build expertise and to engage in the wider discussion about the impact of such issues on undergraduate mathematics.

The increased government attention on the declining mathematical skills of students and the detrimental impact this will have on the nation's future workforce capabilities (Chief Scientist (2013)) has increased public awareness of the importance of mathematics education and so it is timely that AustMS establish a group with an education focus.

Objectives and activities

The objectives of the Group are to:

(a) contribute to, and participate in, discussion about university mathematics education issues including threshold learning outcomes, achievement standards, assessment practices, transition issues, using technology in the classroom and innovative teaching practices;
(b) strengthen relations between the university and secondary mathematics education communities;
(c) promote innovation in university mathematics teaching and learning by providing a forum for showcasing good practice;
(d) promote research in undergraduate mathematics education through identifying challenges that require investigation and providing a forum for discussion;
(e) foster inquiry and discussion of university mathematics education; and
(f) provide opportunities for mathematicians to network, share experiences and discuss their current practices.

To further these objectives, the Group will organise and participate in a range of activities that will include:

(a) conferences, meetings, seminars, lectures or other events for members of, and visitors to, the Group;
(b) gathering and providing information on current issues in mathematics education;
(c) sponsoring joint activities with other bodies concerned with the areas covered by the Group;

(d) encouraging the interaction of mathematicians to become more involved in education innovation and research;

(e) building a sense of community for mathematicians interested in improving the teaching of mathematics and those also involved in the scholarship of teaching mathematics; and

(f) liaising with the Society's Standing Committee on Mathematics Education on issues which are of interest to the group and relevant to Society policy.

The group is open to all AustMS members as well as non-members who can elect to join the group separately. The AustMS membership form now includes the option to nominate for membership of this group. We are also asking those interested in joining to contact us to nominate for the group, so we can initiate communication and organise events as soon as possible. Please email Joann Cattlin (joann.cattlin@unimelb.edu.au) if you would like to join SIGME.

The Executive Committee has been established with an interim Chair, Dr Deborah King and interim Secretary, Joann Cattlin, with an interim Treasurer to be appointed at the 2015 AustMS meeting in Adelaide. The first full election of the committee will be held in January 2017.

Inaugural meeting

The group will meet for the first time at the AustMS 2015 meeting at Flinders University in September (date to be confirmed). We encourage all AustMS members with an interest in mathematics education to attend this meeting to help set the direction for the new group.

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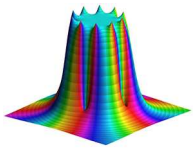
Effective Visualisation in the Mathematical Sciences

EViMS 2



The Australian National University
21–23 November 2014

Louisa Barnsley*

This workshop took place over an extremely hot Canberra weekend in the Mathematical Sciences Institute (MSI). Despite the heat, all sessions from start to finish were well attended by the 23 participants and the quality of most of the presentations was excellent. This workshop was a sequel to EViMS held at the University of Newcastle in 2012. It is planned that EViMS events will provide an ongoing forum for mathematical researchers and educators with an interest in visualisation.

The goals of the meeting were to bring together experts from universities, schools and the private sector and to pool their knowledge on visualisation tools supporting mathematics teaching, experimental mathematics and visualisation as an aid in the proving of theorems.

The workshop had excellent keynote speakers in Elias Wegert (TU Bergakademie Freiberg) on exploring complex functions using phase plots, Peter Eades (University of Sydney) analysing what makes for a good diagram, Andrei Tetenov (Gorno-Altaisk University) showing 3D iterated function system attractors and Christoph Bandt (University of Greifswald) on the practical issues of visualising 'big data'. They were supported by 11 other speakers from Australia and overseas. A feature of the conference was seeing the practical results some speakers had achieved with computer-based tools. For example, Anthony Morphett (Melbourne) and Krzysztof Leśniak (Nicolaus Copernicus) both presented *GeoGebra* applets for teaching undergraduates, Andrei Tetenov presented results from *IFS-Builder 3D* and Elias Wegert showed what his MATLAB®-based, *Complex Function Explorer* could achieve.

The heart of the conference was the talk by Lilia Ferrario (ANU). She gave an overview of learning state-of-the-art showing there are three types of mathematical minds: an analytic type, a geometric type and a harmonic type, and two components of thinking processes: verbal-logical that enables people to work with

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abstract problems, and visual-pictorial which requires visualisation. The most effective teaching or any other type of presentation will include elements that present the material in ways that can be accessed efficiently by all the different types of student minds. The same ideas also apply in research, especially when the research involves very large amounts of data.

At the conclusion of EViMS 2 there was a great deal of enthusiasm from the participants that a third EViMS should be organised in two years time, probably at the University of Newcastle. The MSI will set up a website to provide a forum and a focus for people with an interest in visualisation between now and EViMS 3.

EViMS 2 was supported by AMSI, AustMS, CARMA, ANU and ACEMS. Further details are available at http://maths.anu.edu.au/evims-2 and the talks are available at http://maths.anu.edu.au/people/louisa-barnsley.

Kenneth Robert Pearson

1943–2015

Ken Pearson was born on August 21, 1943. He graduated in mathematics with first class honours at the University of Adelaide in 1963 and was awarded a Ph.D. in pure mathematics at the same university in 1966 for his thesis on Topological Semirings.

Forty years later in 2006 Ken was elected as a Fellow of the Academy of Social Sciences in Australia. The nomination citation stated:

> Ken Pearson is one of only a handful of Australian academics who have made a significant difference to the world of economics.

The difference he made and how he transitioned mid-career from theoretical mathematics to practical economics is a story of intellectual curiosity, insight, courage and perseverance.

Ken's career in mathematics started along conventional lines with initial appointments as lecturer at Adelaide and assistant professor at Penn State. In 1970 he joined the newly established La Trobe University as senior lecturer. In mathematics Ken made major contributions in teaching, administration and research.

In teaching, Ken together with Arthur Jones developed the La Trobe teaching strategy. A distinctive aspect was the introduction of tutorial rooms where every wall is a blackboard on which students work in small groups. This tutorial style spread from La Trobe and is the forerunner of the modern notion of a flipped classroom.[1] Ken also played a key role in the development of La Trobe's pure mathematics subjects, leading to the publication of *Abstract Algebra and Famous Impossibilities* (Springer, New York, 1991), jointly with Arthur Jones and Sid

[1]See Katherine A. Seaton *et al.* http://www.austms.org.au/Gazette+Volume+41+Number+2+May+2014.

Morris. The book was well-loved by students and favourably received professionally (*Gazette* review by George Willis[2]).

In administration Ken made a fundamental contribution to the ongoing health of mathematics at La Trobe. In the early '80s, as Chairman of the Department of Pure Mathematics, he initiated and guided through Academic Board the merger of the Departments of Pure Mathematics and Applied Mathematics. The amalgamation proved a resounding success. As a leader, Ken was universally respected for his integrity, his approachability, his ability to get things done and his thoughtful, fair and balanced decisions.

In research Ken had published six papers in topological semirings prior to his arrival at La Trobe where his attention shifted to the group of units in a ring. Ken continued to work in ring theory throughout the '70s with a particular interest in skew polynomials and polynomial matrix identities. His work on polynomial matrix identities over non-commutative rings involved the computer-aided solution of large systems of sparse linear equations. And this provided the link to economics.

Ken learnt from Russell Rimmer, a former student, that large sparse systems were of central importance to a group in the La Trobe Economics Department working in the field of Computable General Equilibrium (CGE) modelling. The La Trobe group, led by Peter Dixon, was contributing to the Federal Government's IMPACT Project, headed by Alan Powell at the University of Melbourne. Ken invited Peter to give a seminar in the maths department, and the encounter changed the course of his career.

The seminar sparked Ken's intellectual curiosity. He delved into the IMPACT Project and found that CGE modelling is all about links between different parts of the economy. IMPACT was particularly concerned with links between tariff-protected, import-competing industries (e.g. textiles, clothing & footwear and motor vehicles) and export-oriented industries (e.g. agriculture and mining). IMPACT's CGE model, ORANI, quantified the path from cuts in tariffs, to increased imports, to a lower exchange rate, to increased exports. This was important for reassuring politicians that tariff cuts would not have a disastrous effect on aggregate employment: it demonstrated that jobs lost in import-competing industries would be replaced by jobs in export-oriented industries.

Ken sensed that what was going on at IMPACT was important. ORANI was gaining political traction and was used effectively in-house and at the Industries Assistance Commission. Ken knew that IMPACT was keen to facilitate wider use but this was inhibited by computational complexity. His insight was to see that dissemination could be achieved via computationally efficient, easily transportable, user-friendly software.

Enthusiastically backed by Alan Powell, Ken set himself the assignment of creating the right software platform. Large-scale, policy-relevant CGE models contain many thousands of variables and non-linear equations. Making them computationally efficient and widely accessible must have seemed a monumental task. Embarking

[2]Australian Mathematical Society Gazette Volume 21 Number 1 March 1994.

on it was an intellectually courageous decision. For Ken, it required a break from his familiar world of mathematics at considerable risk to his burgeoning career. But he succeeded. The outcome was the GEMPACK software.

The first version of GEMPACK was unveiled at a training course on the ORANI model for public servants and academics held in 1984. Over the next 30 years, Ken continuously developed and improved GEMPACK, working with several collaborators, most notably Mark Horridge.

GEMPACK is now used in 600 sites including the World Bank, the International Monetary Fund, the Asian Development Bank, the Global Trade Analysis Project (GTAP), the Australian Treasury, and numerous government departments and universities in more than 90 countries. In a recent computational comparison with the other major CGE software platform (GAMS, developed at the World Bank), GEMPACK was the overwhelming winner.

Through GEMPACK, Ken democratized CGE modelling. Using GEMPACK, economists without specialist computational expertise can build and apply sophisticated models. GEMPACK-generated results can be readily analysed and constructively challenged in policy debates ranging across trade, public finances, industry assistance, microeconomic reforms, greenhouse and other environmental policies, immigration, labour markets, macro stimulus, natural disasters and security. GEMPACK has linked the world-wide CGE community by facilitating easy transfer of models and results.

What were the factors behind GEMPACK's spectacular international success? First, there was Ken's superb technical prowess and his ability to draw on his mathematical knowledge (e.g. understanding of sparse-matrix techniques) in solving practical computing problems. Second, there was Ken's perseverance, focus and hard work over more than three decades.

Just as important as these factors was Ken's personality: gregarious; intellectually honest; inquiring; always up for a challenge; and completely free of pretension. These characteristics enabled Ken to work productively alongside economic modellers at the IMPACT Project and its successor, the Centre of Policy Studies (CoPS, now located at Victoria University in Melbourne). Starting in the 1990s, Ken also became a key member of a huge economic modelling network centred on GTAP. Because of his ability to communicate with economists and operate outside his comfort zone, Ken was able to develop GEMPACK in parallel with the evolving needs of economic modellers.

In recognition of his contributions, Ken was appointed Professor in CoPS in 1999 (then located at Monash University). From 2000 to 2004 he was the much respected Deputy Director of CoPS. In addition to his fellowship in the Academy of the Social Sciences in Australia, Ken received a major international recognition in economics: in 2007 he was in the first group of inductees to the GTAP Hall of Fame.

Ken had many friends and admirers in every part of the world. He was a great participant in life. He was an adventurous tourist. He loved playing golf, tennis and bridge. He was a chorister with the Royal Melbourne Philharmonic. He had

a close-knit family and is survived by Helen, his wife of 50 years, four daughters and nine grandchildren.

Ken retired in 2014 due to illness, leaving GEMPACK in the safe hands of Mark Horridge and Michael Jerie.

He died of cancer on May 12, 2015. Throughout his illness he was stoic, always cheerful and grateful for a good life. Typical of his lifetime attitude, his main concern towards the end was to make things as easy as possible for his family, friends and colleagues.

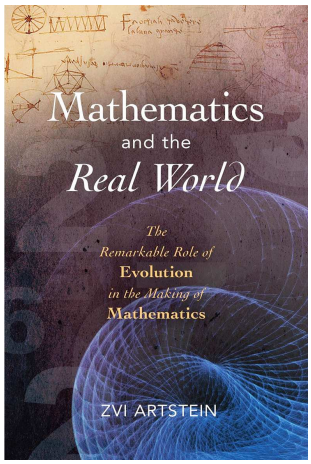
Peter Dixon and Maureen Rimmer, 5 June 2015
Centre of Policy Studies, Victoria University
Email: Peter.Dixon@vu.edu.au, Maureen.Bleazby@vu.edu.au
with contributions by:
Peter Stacey (La Trobe University, email: P.Stacey@latrobe.edu.au) and
Don Taylor (The University of Sydney, email: donald.taylor@sydney.edu.au)

Book Reviews

Mathematics and the Real World

Zvi Artstein
Prometheus Books, 2014, ISBN 978-1-61614-091-5

Zvi Artstein is a distinguished Professor of Mathematics, specialising in Control Theory and Game Theory, at The Weizmann Institute of Science in Israel. This book, subtitled 'The remarkable role of Evolution in the making of Mathematics', is a translation from the Hebrew, so we may assume that its original target audience was lay persons and mathematics students and teachers in Israel. Its intent is to describe the relationship between mathematics and the physical and social world, based on the concept that intellectual advances are driven by evolutionary pressure.



The book is a historical and philosophical account of the development of mathematics with emphasis on aspects such as simple arithmetic, spatial visualisation and pattern recognition which can be related to evolution by natural selection. This is an interesting approach, well worth serious consideration. Unfortunately, the author adduces no evidence from evolutionary anthropology, biological genetics, DNA analysis or cognitive science to support his theories, relying rather on folk psychology and 'Just–So' stories. Unsurprisingly, he deduces that most applied mathematics but precious little pure mathematics has an evolutionary advantage.

Interspersed in the text, which generally avoids technicalities, are paragraphs in a different font, which the author invites the uninterested reader to skip, and which are supposed to contain more sophisticated mathematical arguments. Unfortunately, these sections themselves are often historically inaccurate and mathematically misleading. Here for example in its entirety, is Artstein's explanation of how Newton verified Galileo's observation on the path of a falling object:

> Newton showed that the derivative of the function $a(t) = \alpha t^n$, where α is a constant, is $\alpha n t^{n-1}$. In particular, if the second derivative has a fixed value g, its integral is gt, and the integral of the latter is $\frac{1}{2}gt^2$. This shows that as the Earth's gravitational pull g is constant over short distances, the parabolas that Galileo observed when he dropped bodies from the top of a tower fulfilled Newton's second law of motion.

The historical account, ranging from tallying by pre-historic humans, astronomy and mensuration in bronze-age agricultural societies, Greek mathematics and medieval astronomy, through Galileo and Newton to the early moderns such as Euler and the Bernoullis, contains nothing novel and is riddled with errors, of which the most egregious are: the Babylonians inscribed calculations on potsherds; Euclid developed axiomatics in order to avoid optical illusions in diagrams; Greek mathematicians studied the brachistochrone problem; Fermat's Last Theorem occurs among Hilbert's list of unsolved problems presented at the 1900 International Mathematical Congress. The author is on firmer ground when dealing with the history of the mathematics with which he is most familiar: the principle of least action, calculus of variations, statistics and the social sciences and computation. He also has a perceptive chapter on the nature of research in mathematics.

The book contains frequent observations on how mathematics should be taught and learned. However, the author's remarks on mathematics education are, in the reviewer's opinion, one-sided and extreme.

Some of the foregoing negative comments must have filtered through to the author or his publisher during the process of publication, because Artstein concludes with a poignant Afterword, imploring readers to forgive his errors, since Evolution did not prepare us for error-free rigorous analysis!

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Neverending Fractions
An introduction to Continued Fractions*

Jonathan Borwein, Alf van der Poorten, Jeffrey Shallit and Wadim Zudilin
Australian Mathematical Society Lecture Series, number 23
Cambridge University Press, 2014, ISBN 978-1107-00665-2
Also available in eBook (ISBN 978-0-511-90265-9)

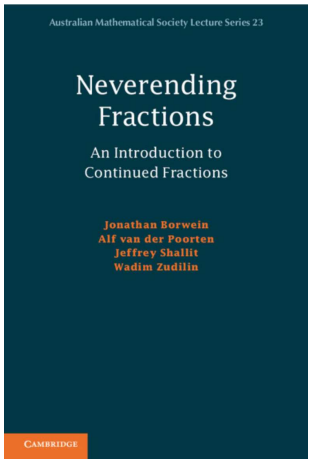
Continued fractions form a classical area within number theory, the roots of which can be traced back to Euclid's algorithm for the greatest common divisor of two integers (300 BC). Several centuries ago, Rafael Bombelli (1579), Pietro Cataldi (1613), and John Wallis (1695) developed the method of continued fractions for rational approximations of irrational numbers (such as square roots), and later on great mathematicians like Leonhard Euler (1737 and 1748), Johann Lambert (1761), Joseph L. Lagrange (1768 and 1770), Carl Friedrich Gauss (1813), and others discovered various fundamental properties and important applications of

*The *Gazette* thanks *Zentralblatt MATH* and Werner Kleinert for their permission to republish this review, which originally appeared as Zbl 1307.11001.

continued fractions. In fact, these fascinating objects have been a very active field of research ever since, and the vast contemporary literature on continued fractions evidently shows that this topic is still far from being exhausted.

The book under review grew out of many lectures that the four authors delivered independently on different occasions to students of different levels. Its main goal is to provide an introduction to continued fractions for a wide audience of readers, including graduate students, postgraduates, researchers as well as teachers and even amateurs in mathematics. As the authors point out in the preface, their intention is to demonstrate that continued fractions represent a neverending research field, with a wealth of results elementary enough to be explained to this target readership.

Regarding the precise contents, the book comprises nine chapters, each of which is divided into several sections. While the first three chapters are devoted to a general introduction to continued fractions, the subsequent six chapters deal with more special topics and applications of the theory.



Chapter 1 presents the necessary prerequisites from elementary number theory with full proofs. These concern the following themes: divisibility of integers and the Euclidean algorithm, prime numbers and the fundamental theorem of arithmetic, Fibonacci numbers and the complexity of the Euclidean algorithm, approximation of real numbers by rationals and Farey sequences. Chapter 2 begins the study of continued fractions and their algebraic theory, thereby explaining the continued fraction of a real number in general, the principle of Diophantine approximation, the continued fraction of a quadratic irrational and the Euler–Lagrange theorem in this context, the construction of real numbers with bounded partial quotients, and other results on rational approximation.

Chapter 3 touches upon the metric theory of continued fractions, with emphasis on the growth of partial quotients of a continued fraction of a real number, the approximation of almost all real numbers by rationals, and the classical Gauss–Kuzmin statistics in metric number theory. Chapters 4, 5 and 6 originate in lectures that one of the authors, the late Alf van der Poorten (1942–2010), gave in the last few years before his untimely death.

Chapter 4 is titled ‘Quadratic irrationals through a magnifier’ and contains some informal lectures on continued fractions of algebraic numbers, Pell’s equation, and some concrete examples.

Chapter 5 is a survey of aspects of continued fractions in function fields, with a view toward some so-called (recursively defined) Somos sequences, pseudo-elliptic integrals, and hyperelliptic curves, whereas Chapter 6 briefly discusses the relationship between neverending paper foldings and continued fractions. Chapter 7 provides the study of a class of generating functions that are connected to remarkable

continued fractions and rational approximations. Lambert series expansions of generating functions and an inhomogeneous Diophantine approximation algorithm are the main tools applied here.

Chapter 8 treats the Erdős–Moser equation

$$1^k + 2^k + \cdots + (m-2)^k + (m-1)^k = m^k$$

and its possible integer solutions for $m \geq 2$ and $k \geq 2$.

A conjecture by P. Erdős states that such solutions do not exist, and L. Moser proved in 1953 that only for even exponents k and rather large integers m such solutions could be expected at all.

In this chapter, both the arithmetic and the analysis of the Erdős–Moser equation are outlined, where efficient ways of computing certain associated continued fractions as well as explicit bounds for solutions are presented. The basic reference for this chapter is the recent paper by Y. Gallot, P. Moree and W. Zudilin (*Math. Comput.* **80,** No. 274, 1221–1237 (2011; Zbl 1231.11038)).

The concluding Chapter 9 finally turns to irregular continued fractions by surveying their general theory as well as some important examples, including Gauss' irregular continued fraction for the hypergeometric function, Ramanujan's arithmetic-geometric mean (AGM) continued fraction (from his second notebook) and related developments by one of the authors of the present book (J. Borwein) and his collaborators, an irregular continued fraction for the zeta value $\zeta(2) = \pi^2/6$, and a new proof of R. Apéry's theorem on the irrationality of $\zeta(3)$ as a striking application of the foregoing discussion.

There is an appendix to the main text containing a collection of interesting continued fractions, both regular and irregular, where most of those represent special real numbers, values of special functions, particular infinite series, and some q-series, respectively. As one can see, the book is a combination of formal and informal styles of expository writing, and a mixture of introductory textbook and topical surveys likewise. Many of the special topics discussed in the later chapters are not to be found in other books but only in scattered articles and lectures. As for full details with regard to these topics chapters, the reader is referred to the original research papers listed in the rich bibliography. In fact, each chapter ends with a set of notes providing additional remarks and hints for further reading, and a few exercises invite the reader to acquire complementary knowledge through independent work.

All together, the present book gives a beautiful panoramic view of the 'neverending story of neverending fractions' by making apparent their naturalness, their ubiquity, and their wide-range of applications in very lucid and inspiring a manner.

Werner Kleinert
Berlin

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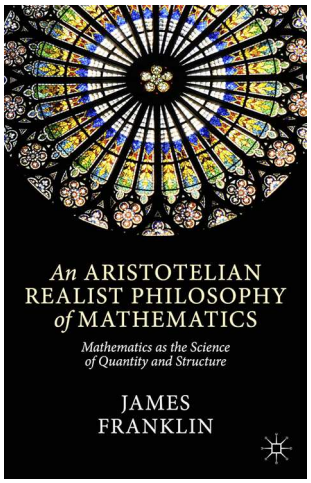
An Aristotelian Realist Philosophy of Mathematics

James Franklin
Palgrave Macmillan, 2014, ISBN 978-1-137-40072-7

What are the current trends in philosophy of mathematics, and what relevance do they have to the practice of mathematics? Those are some of the questions I asked myself when I began reading this book by James Franklin, Professor of Mathematics at UNSW and founder of the 'Sydney School' in the philosophy of mathematics.



There are a few hurdles to overcome for a lay person attempting to read a book or paper in philosophy. The first is the jargon. Some phrases, such as 'epistemology and ontology', 'mereology', 'potentially infinite' (which just means unbounded) are clearly defined in dictionaries and Wikipedia and pose no real problem. But others, such as 'necessary', 'contingent', and 'uninstantiated universal' are ambiguous or depend on individual psychology. Even more troubling are words such as 'random' which have different meanings in mathematics and philosophy. A striking example is the claim by the author that the sequence of decimal digits of π and even a finite initial segment of this sequence, is random. Random, it seems, is in the eye of the beholder.

A second feature of the philosophical literature is its polemical tone. Unlike the polite euphemisms one finds in mathematical papers which point out errors or incomplete proofs, philosophical papers bristle with words like 'mistaken', 'ill-informed' and 'falsity'. In mathematics I have only seen something approaching this in papers on the foundation of probability espousing the frequentist or Bayesian approach.

So what are the principal opposing schools in mathematical philosophy today? According to Franklin they are Platonism, which holds that mathematics is about the real world, and Nominalism which claims it is about words. They correspond roughly to what mathematicians call platonism and formalism. (I use lower case for the mathematical concepts to distinguish them from the slightly different philosophical meaning). But whereas mathematicians see no contradiction in embracing platonism when doing research and formalism when writing it up, philosophers view this as akin to treason.

Within Platonism there are again two competing views of mathematics. One is Platonic Idealism, which holds that the real world is an approximation to mathematics, and the other is Aristotelian Realism which holds that mathematics is an approximation to the real world. The author is firmly in the latter school,

proclaiming mathematics to be the science of quantity and structure. For example, the number 6 is the property of a heap of six apples which distinguishes it from a heap of five apples. Similarly, 1 meter is the length of a chalk line measured with a standard rod, and a sphere is the shape of a bronze ball. Franklin is well aware that a straight line drawn on paper is neither straight nor a line, a 1000-sided regular polygon is indistinguishable from a circle and a bronze ball is not a sphere. He deals with this problem by associating with each real entity a tolerance, in the engineering sense.

For Aristotelian Realists, the space in which we live is locally Euclidean and its properties are not postulated, but observed and verified. The arithmetic of the integers and their ratios make sense, and we can define an action of the rationals on the continuum. Since there is no natural choice of a unit of measure, there is no embedding of the rationals in the real line, so it is not obvious if and how the arithmetic of the real and complex numbers is related to that of the integers and rationals. The topology of space and hence continuous real functions can be defined intrinsically, but Franklin does not address the question of smoothness and the existence of pathological functions.

The claim that mathematics concerns the real world extends also to structures. Franklin defines a mathematical property to be structural if it can be defined in terms of the concepts 'same and different' and 'part and whole'. For example an entity is symmetrical if it consists of two parts which are the same in some respect. What 'in some respect' means is apparently a property of human cognition. Among the problems with this concept are the cognitive errors of apophenia (the human tendency to perceive patterns in random or meaningless information), and the opposite error of failing to recognise a pattern that exists. Terry Tao, for example, sees relations between the eigenvalues of the random matrix and the distribution of zeroes of the Riemann zeta function that I do not.

A major claim of the author is that while pure mathematicians may be more comfortable in the Platonic universe, Aristotelian Realism is especially appropriate for applied mathematics. One breathtaking suggestion is that the applied mathematician need not be concerned with infinity because applied mathematics only deals with finite objects. This concentration on small concrete cases has the unfortunate consequence that the author fails to take account of the importance of generalisation. For example, according to Franklin, the purpose of Euler's Königsberg Bridges paper was to prove that the burgers of Königsberg could not stroll over all their bridges just once.

A major problem associated with Realist mathematics is the question of infinity, both discrete and continuous. The author recognises that it must be faced in any coherent mathematical system, and his partial solution is the notion of 'uninstantiated universals', that is, entities that could exist but do not, the philosopher's favourite example being the golden mountain. By invoking uninstantiated universals, Franklin allows Realist mathematics to admit large cardinals when required. But when explaining the reliance of mathematics on logical reasoning, he fails to address the problem of the internal consistency of Aristotelian Realism. There should be no need for this, because if mathematics is only about the real world, it

has a model. But as soon as uninstantiated universals enter the picture, so does the possibility of logical contradiction. For example using arguments valid in Realism with uninstantiated universals, Gödel constructed a consistent universe in which $2^{\aleph_0} = \aleph_1$, and Cohen one in which $2^{\aleph_0} > \aleph_1$. Whereas formalist mathematicians are happy to pursue the consequences of accepting or denying the continuum hypothesis, to the Realist their truth or falsity is a property of the real world.

It is easy to ridicule such attempts to rewrite mathematics. It is more useful to consider which aspects of mathematics can be developed using an Aristotelian Realistic foundation when we allow a cautious interpretation of uninstantiated universals. Firstly ZF Set Theory, including the axiom of infinity but without the unrestricted axiom of choice, is realistic and can be used to define functions and relations. Furthermore, the arithmetic of the integers and their ratios make sense. We can embed the field of rationals in a complete Archimedean ordered field and so construct real and complex numbers and vector spaces with their associated topology. However, notions of compactness that require choice are not allowed, so that classical analytic and harmonic analysis remain out of reach. Elementary number theory makes sense and so does finite combinatorics. We can define algebraic structures, but lacking the maximum principle, we cannot prove the existence or properties of maximal normal substructures except in the finite case.

To my mind, too much is lost without a platonic and formalistic approach.

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WORKSHOP
IN HONOUR OF
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THE UNIVERSITY OF NEWCASTLE
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7 - 8 DECEMBER
THE UNIVERSITY OF MELBOURNE
CONFERENCE ON
GEOMETRIC
REPRESENTATION
THEORY
14 - 18 DECEMBER
THE UNIVERSITY OF QUEENSLAND

Nalini Joshi*

Mathematics by Inquiry

The Mathematics by Inquiry Request for Tender (RFT) was opened by the Australian Government on 29 July 2015. By the time you are reading this column, the call for tender would have closed; it closes on 24 August 2015. In this column, I would like to (i) highlight elements of the tender document, which make interesting reading; and, (ii) ask you to reflect on whether this will resolve the troublesome issues in Australia's mathematical education pointed out by many organisations.

The Department of Education and Training website [1] summarises the tender's purpose:

> The RFT is seeking tenders to develop, disseminate and ensure widespread awareness and uptake of a suite of mathematics teaching and learning resources for Foundation to Year 10 students, teachers and school leaders. These resources will support an inquiry based approach to the teaching of mathematics in Australian schools.

The detailed tender document is available from AusTender [2].

The major part of the document contains standard tender requirements. The matters concerning services on mathematics education are outlined in the appendices. Appendix A provides the background, related projects and actions. The following item is particularly interesting:

A.2.5 "There is a general consensus among mathematics education experts that the traditional 'teach by the text-book' pedagogical approach needs to change to focus much more on problem-solving and reasoning in order to better equip students with the STEM skills they need for their future employment." (p. 24)

As a result of the two Desktop Reviews of Mathematics School Education, Pedagogical Approaches and Learning Resources, carried out by the Australian Association of Mathematics Teachers and the Australian Academy of Science, and the Mathematics by Inquiry policy roundtable, held 7 May 2015, the department has already commissioned the following initiatives:

(a) Education Services Australia (ESA) has been engaged to undertake a curation and annotation of Australian Curriculum: Mathematics resources listed

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on Scootle to describe these resources more specifically and to give teachers a better sense of which resources can support their needs;

(b) The Australian Curriculum, Assessment and Reporting Authority (ACARA) has been engaged to develop annotated work samples to support the Australian Curriculum: Mathematics proficiencies, focusing on problem-solving and reasoning. (p. 24)

Appendix B details the services requested and essential requirements. Item B.1.1 gives a detailed set of requirements starting with "a vision for mathematics education in schools" (item B.1.1.a.i.A., p. 26). The remainder of B.1.1 outlies an ambitious and challenging set of requirements covering not only "innovative, high quality mathematics teaching and learning resources" to be developed, and key risks, but also addressing "individual teacher learning, classroom practice and whole of school culture" in a way that "increases student engagement, performance and retention in mathematics."

There are two phases to the work requested by the current tender. Each phase is expected to take 12–18 months. While the successful tenderer will be offered a contract for phase 1, the continuation to phase 2 is an option available at the sole discretion of the department or agency overseeing the tender on behalf of the Australian government. The aim is to develop resources that will be "readily discoverable and freely accessible online to Australian teachers." The successful tender will result in a contract which is expected to commence on 1 October 2015.

I am looking forward to the announcement of the outcome of this call for tender and also to the very important work expected to be carried out by the successful contractor. Let's hope that in three years time this initiative will have resulted in a game-changer for mathematics education in Australia.

References

[1] Request for Tender in relation to Mathematics by Inquiry, http://www.studentsfirst.gov.au/restoring-focus-stem-schools-initiative, accessed 08 August 2015.
[2] Available under RFT PRN AD15003424, from https://www.tenders.gov.au/.

Nalini Joshi is an ARC Georgina Sweet Laureate Fellow and the Chair of Applied Mathematics at The University of Sydney. She was the President of the Australian Mathematical Society during 2008–2010, elected a Fellow of the Australian Academy of Science in 2008, became the Chair of the National Committee of Mathematical Sciences in 2011, and is a member of the Commonwealth Science Council of Australia.

FINANCIAL INVESTMENTS

A Modeller's Minefield

Budgeting, it's a cringe worthy word. Optimisation, that sounds more like it! But have you the faintest idea of what it is? And did you know that mathematicians use it to help financial planners increase the expected size of their client's financial nest egg with risks that are acceptable to them and their stage in life?

AMSI Intern, Wei Wu, is well versed in the mathematical technique of optimisation used in finance. In fact, he recently completed an internship at Optimo Financial. Hugh Bannister, Principal, Optimo Financial, has been building energy and financial models using optimisation techniques for over 25 years. He believes the work completed during Wei's internship will allow Optimo to improve its offerings to the market.

One of the challenges in providing good advice is to take careful account of risk. Depending on the client's attitude and stage in life, a conservative or somewhat more aggressive investment strategy may be appropriate. However, it is very difficult to balance all the factors that would deliver a satisfactory strategy for each client's needs. Standard portfolio theory is more designed for institutional investors than individuals.

"People have different investment needs, some invest for the short-term, saving for a house deposit, or long term, saving for their retirement. I was able to apply my mathematical skills to help financial planners find the best investment strategies for their clients by looking at, and taking into account, numerous factors," Wei says.

Hugh tells us: "Optimo had developed an approach to solving this problem. The academic mentors and Wei Wu were able to make certain the proposed approach was theoretically and practically sound and were also able to explore possible improvements."

> *[The intern] was able to make certain the proposed approach was theoretically and practically sound and was able to explore possible improvements.*
>
> Hugh Bannister,
> *Principal, Optimo Financial*

OPTIMO financial

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AMSIIntern

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AMSI News

Geoff Prince*

AMSI Media Release August 6, 2015: Vision for a Maths Nation

Australia's future as a high technology, research-driven economy will depend on reversing 20-year trends in the mathematical sciences, according to a new report by the Australian Mathematical Sciences Institute (AMSI).

Today, AMSI release their fourth annual *Discipline Profile of the Mathematical Sciences*. At a time when the Australian government is responding to the Chief Scientist's call for a strategic plan for Science, Technology, Engineering and Mathematics (STEM) it is a reminder that we cannot continue to rely on piecemeal programs tied to the electoral cycle.

The data collected for the 2015 publication paints a mixed picture of Australian engagement with the mathematical sciences.

86 per cent of science degrees do not have intermediate mathematics as an entry prerequisite while Year 12 enrolments slide

In fact, mathematics prerequisites for entry into science, commerce and engineering degrees are at historic lows.

AMSI Director, Professor Geoff Prince insists: "Universities must phase in restoration of maths prerequisites; the lack of them sends a negative and misleading message to schools about the value of these subjects."

Intermediate and advanced mathematics subjects are the gateway to quantitative professions; the 20-year decline in participation is choking the country's galloping demand for graduates with these skills. And it has the potential to halt the nation's productivity growth.

At least 30 per cent of Year 7–10 maths classes are taught without a qualified maths teacher

This figure is more than double the international average and must be repaired as part of our STEM planning.

In order to secure the future supply of mathematics teachers we need to know why potential educators aren't choosing to be maths teachers. The only immediate solution is to provide professional development to the many conscientious and professional educators teaching maths out-of-field.

*Australian Mathematical Sciences Institute, Building 161, c/- The University of Melbourne, VIC 3010, Australia. Email: director@amsi.org.au

This is a national issue requiring national leadership; state and federal governments must act together to solve the teacher supply problem.

Women make up only 30 per cent of undergraduate maths enrolments holding back our STEM workforce and productivity growth

The proportion of females represented at all stages of the mathematics pipeline is inadequate. A significant consequence of this is that female adult numeracy is below that of males — around 30 per cent in some age groups. And, in terms of the national economy, it is widely recognised that weak participation by women in STEM fields is handicapping Australia's productivity and competitive advantage.

"We are proud to be working with the BHP Billiton Foundation to increase participation of girls and women in study and career pathways involving mathematics and statistics", says Professor Prince.

Maths' multi-billion dollar value to the economy under threat as PhD rate stagnates

A 2015 report by the Australian Academy of Sciences indicates that, of those business sectors based on a single core discipline, mathematical sciences account for the top three (and five of the top seven). The report also highlighted that the direct impact of advanced physical and mathematical research is worth $145 billion to the economy per year, the flow-on impact amounts to $292 billion per year. This is in stark contrast to 54 per cent of adult Australians having only basic numeracy skills and the proportion of Year 12 students studying 'harder' maths in steady decline.

"Unfortunately, this stellar contribution hides an alarming trend", says Professor Prince. "Governments are trying to drive up business employment of STEM trained research professionals, however, domestic PhD numbers in the mathematical sciences are among the very lowest in the OECD. Universities and businesses must improve engagement to maximise the economic benefits of mathematics and statistics."

The *2015 Discipline Profile of the Mathematical Sciences* is accompanied by a policy document — *Vision for a Maths Nation* — that identifies four key priorities to reverse these confronting trends:

1. Restore university maths prerequisites from their historic low and turn around declining school mathematics enrolments
2. Train the unqualified teachers of school mathematics and secure the supply of future qualified maths teachers
3. Increase the number of girls studying maths and women employed in the quantitative professions
4. Boost the engagement of Australian business with mathematical sciences research

Australia's Chief Scientist, Professor Ian Chubb, has called for action: "It's time to do what so many other countries have already done: take a long-term strategic view of STEM's pivotal role in securing a stronger Australia."

Media release prepared by Stephanie Pradier.

2015 Discipline profile can be found at http://amsi.org.au/publications/discipline-profile-of-the-mathematical-sciences-2015/.

2015 Policy document *Vision for a Maths Nation* can be found at http://amsi.org.au/publications/a-vision-for-a-maths-nation/.

I was a Monash undergraduate and took out a La Trobe PhD in 1981 in geometric mechanics and Lie groups. This was followed by a postdoc at the Institute for Advanced Study in Dublin. I've enjoyed teaching at RMIT, UNE and La Trobe. My research interests lie mainly in differential equations, differential geometry and the calculus of variations. I'm a proud Fellow of the Society, currently a Council and Steering Committee Member. I became AMSI director in September 2009.

2015 MAHLER LECTURE TOUR

2014 Fields Medalist

Professor Manjul Bhargava

Princeton University

Touring Australia September—October

Photo courtesy of Infosys Science Foundation

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ANZIAM

Research

WWW.AMSI.ORG.AU/MBLECTURE

AUSTRALIAN MATHEMATICAL SCIENCES INSTITUTE

News

General News

MATRIXMelbourne

The University of Melbourne has decided to establish a MAThematical Research Institute, to be known as MATRIX. In the spirit of a number of overseas institutes, it aspires to be a destination for research-intensive, residential programs, where internationally renowned scientists can engage with the Australian mathematical sciences community for significant periods of time. The activities of MATRIX will take place at a fixed venue in regional Victoria (initially at Creswick).

MATRIX has put out a call to prospective organisers to apply for funding to organise a MATRIX program. A website with further information which will be published online soon. In the meantime, contact office@matrixatmelbourne.org.au. In particular, send applications for 2016 funding to this address before Friday 30 October.

Nalini Joshi: Women of Influence 2015

Professor Nalini Joshi has been announced as one of The Australian Financial Review and Westpac Women of Influence for 2015. The 100 Women of Influence were listed in the The Australian Financial Review on Thursday 24 September 2015. The overall winner and category winners will be announced at the Annual Gala held at the Sydney Town Hall on Thursday 15 October 2015.

The 100 Women of Influence Awards seek to recognise and highlight the profound ways influential women are driving change to create a more diverse future in Australia.

Our congratulations to Nalini!

International Mathematics Olympiad

This year, in the International Mathematics Olympiad, Australia achieved its highest-ever placing of 6th (behind only the United States of America, People's Republic of China, Republic of Korea, Democratic People's Republic of Korea and Vietnam). Held in July in Thailand, the competition attracted almost 600 competitors from 104 countries.

Australian Team members included Alexander Gunning, from Glen Waverley Secondary College in Melbourne, who scored a gold and was ranked fourth overall, and Seyoon Ragavan, a year 11 student at Knox Grammar in Sydney, who also won a gold medal and and was ranked nineteenth overall. The other four team members all won silver medals. Our congratulations to all of them.

See http://www.imo-official.org/year_country_r.aspx?year=2015 for further details. A more detailed report will appear in the next issue.

Heidelberg Laureate Forum

The Heidelberg Laureate Forum is an annual meeting bringing together winners of the most prestigious scientific awards in Mathematics (Abel Prize, Fields Medal and Nevanlinna Prize) and Computer Science (ACM Turing Award) with a select group of highly talented young researchers. Roughly 200 young scientists from all over the world have the unique opportunity to interact with their scholarly role models during lectures, panels and discussions. At the same time, the up and coming scientists can engage in inspiring and motivating conversations with the laureates during various social events. The Heidelberg Laureate Forum provides a platform for scientific dialogue across generations.

This year's took place 23–28 August, and five Australian research students and postdocs were selected to participate.

Our congratulations to:

- Philipp Bader, La Trobe University
- Anna Tomskova, The University of New South Wales
- John Tsartsaflis, La Trobe University
- Matthew Tam, The University of Newcastle
- Melissa Lee, The University of Western Australia.

They all received funding from AMSI and AustMS to support their attendance at the event.

See http://research.amsi.org.au/hlf for further details about these young researchers, and http://www.heidelberg-laureate-forum.org/ for details about the event. A more detailed report from them will appear in the next issue.

Ian Sloan: 50 years at UNSW

On 31 July, the School of Mathematics and Statistics joyfully came together over lunch and celebrated Professor Ian Sloan's 50 years of invaluable service at UNSW.

ANZIAM: The 2016 J.H. Michell Medal — Call for nominations

In honour of John Henry Michell, ANZIAM, a Division of the Australian Mathematical Society, has instituted an award for outstanding new researchers. At most one award will be made annually, but only to a candidate of sufficient merit. No person can receive more than one such award. The selection criteria for the award are:

1. The researcher must have carried out distinguished research in applied and/or industrial mathematics, where a significant proportion of the research work has been carried out in Australia and/or New Zealand; AND
2. On 1 January in the year in which the AWARD is made, the recipient will be within the equivalent of the first ten years of their research-related career*, following the conferral of a PhD**; AND
3. The researcher must have been a member of ANZIAM for at least the** three calendar years preceding the year in which the AWARD is made. Backdating of membership is not acceptable.

Notes: *Allowing for significant interruptions to research development, for example, parental duties, illness, career change.
** Any exceptional circumstances should be forwarded to the Executive Committee to assess eligibility.

Nominations for the AWARD can be made by any member of ANZIAM other than the nominee. A nomination should consist of a brief CV of the nominee together with the nominee's list of publications and no more than a one-page resumé of the significance of the nominee's work. Nominations should be forwarded in confidence, electronically in pdf format, to Associate Professor Harvinder Sidhu (h.sidhu@adfa.edu.au), Chair of the Selection Panel, by 6 November 2015.

Further details of the application process and the award criteria are on the ANZIAM website: www.anziam.org.au/The+JH+Michell+Medal.

The 2016 ANZIAM Medal: Call for nominations

Nominations are now sought for the ANZIAM Medal, which is the premier award of ANZIAM, a division of the Australian Mathematical Society.

Closing date: 6 November 2015.

Nominations for the AWARD can be made by any member of ANZIAM other than the nominee. A nomination should consist of a brief CV of the nominee together with the nominee's list of publications and no more than a one-page resumé of the significance of the nominee's work. Nominations should be forwarded in confidence, electronically to Professor Robert McKibbin (R.McKibbin@massey.ac.nz), Chair of the Selection Panel, by 6 November 2015.

Further details of the application process and the award criteria are on the ANZIAM website: www.anziam.org.au/The+ANZIAM+medal.

Completed PhDs

ANU

- Dr Koenraad Lambertus Van Den Dungen, *Lorentzian geometry and physics in Kasparov's theory*, supervisors: Alan Carey (ANU) and Adam Rennie (University of Wollongong).

Queensland University of Technology

- Dr Matthew Adams, *Mathematical models of calcium and tight junctions in normal and reconstructed epidermis*, supervisor: Dann Mallet.
- Dr Julian Back, *Stefan problems for melting nanoscaled particles*, supervisor: Scott McCue.
- Dr Nicole Cusimano, *Fractional models in space for diffusive processes in heterogeneous media with applications in cell motility and electrical signal propagation*, supervisor: Kevin Burrage.

- Dr Hala Hejazi, *Finite Volume Methods for Simulating Anomalous Transport*, supervisor: Timothy Moroney.
- Dr Daryl Kempthorne, *The development of virtual leaf surface models for interactive agrichemical spray applications*, supervisor: Ian Turner.
- Dr Matthew Moores, *Bayesian computational methods for spatial analysis of images*, supervisor: Kerrie Mengersen.

Swinburne University of Technology

- Dr Afia Naheed, *A study of spatio-temporal spread of infectious disease: SARS*, supervisors: Manmohan Singh, David Lucy and David Richards.
- Dr Afsana Ahmed, *Molecular simulation study of gas storage and separation by novel micropore architectures*, supervisors: Billy Todd (Swinburne University) and Aaron Thornton (CSIRO).

University of Melbourne

- Dr Bin Jia, *Link graphs*, supervisor: David Wood.
- Dr Xiaogang Liu, *Selected topics in spectral graph theory*, supervisor: Sanming Zhou.
- Dr Dean Dres, *Exact confidence intervals for proportions estimated by group testing*, supervisors: Graham Hepworth and Ray Watson.

University of New South Wales

- Dr Bo Wang, *Modelling individual claim development processes in long tail insurance products*, primary supervisor: William Dunsmuir.
- Dr Yuguang Wang, *Filtered polynomial approximation on the sphere*, primary supervisor: Ian Sloan.

University of Sydney

- Dr Nicole Sutherland, *Algorithms for Galois extensions of global function fields*, supervisors: Claus Fieker and Steve Donnelly.
- Dr Alice Dong, *Bayesian analysis of reserving models and applications*, supervisors: Jennifer Chan and Gareth Peters.
- Dr Victor Vera Ruiz, *Recoding of Markov processes in phylogenetic models*, supervisor: John Robinson.
- Dr Sanjaya Dissanayake, *Advancement of fractionally differenced Gegenbauer processes with long memory*, supervisor: Shelton Peiris.

University of Wollongong

- Dr Khaled Sadoon N. Al Noufaey, *Semi-analytical solutions for reaction diffusion equations*, supervisors: Tim Marchant and Maureen Edwards.
- Dr Abdurahim Fares M. Alharbi, *Schedule design for liner shipping networks with port time windows*, supervisors: Pam Davy and Shuaian Wang.
- Dr Asma Olyan M. Alharbi, *The biological treatment of wastewater: mathematical models*, supervisors: Mark Nelson, Annette Worthy and Harvinder Sidhu (UNSWCanberra).

- Dr Amirah Azmi, *Solitary waves in colloidal media*, supervisor: Tim Marchant.
- Dr Luise Patricia Lago, *Imputation of household survey data using mixed models*, supervisors: Robert Clark and Ray Chambers.
- Dr Payam Mokhtarian Dehkordi, *Outliner robust bounded bootstrap small area estimation*, supervisors: Ray Chambers and Thomas Suesse.
- Dr Andrew Holder, *Mathematical models for tumour invasion*, supervisor: Marianito Rodrigo.

Awards and other achievements

Australian National University

Australian Laureate Fellowship for Professor Ben Andrews

Congratulations to Professor Ben Andrews on being awarded an ARC Australian Laureate Fellowship for his project on 'Geometric analysis of eigenvalues and heat flows'. The total funding for this project is $2,080,100. The project summary reads:

> This fellowship project aims to build on Australia's leading position in the areas of nonlinear partial differential equations and geometric analysis to exploit new and highly innovative mathematical methods. It is expected that the methods will affect a range of related fields including stochastic modelling and finance, image processing, and the basic sciences. The project seeks to serve as a focal point for a developing community of Australian researchers in this field, providing a training ground for young researchers and students at the forefront of a vigorous and internationally active area of research, and bringing top international researchers to Australia to interact with the local research community.

For more information see the minister's media release and links therein: http://www.arc.gov.au/media/releases/Minister_FL23June15.htm.

Flinders University

We congratulate Vladimir Ejov, Associate Professor of Mathematics in the School of Computer Science, Mathematics and Engineering. He has been awarded the status of Adjunct Professor at Moscow State University.

La Trobe University

Ioannis (John) Tsartsaflis, a 3rd year HDR student in LTU (supervisors: Yuri Nikolayevsky, Grant Cairns) joins Philipp Bader, post-doc at LTU (supervisor: Reinout Quispel), as two of just five young mathematicians from Australia and of only 100 worldwide who received an invitation to attend the prestigious Heidelberg Laureate Forum (Germany, 23–28 August). John, Philipp, Yuri and Luke Prendergast (Head of Department) featured on the SBS news on 4 August.

University of New South Wales

- Scientia Professor Trevor McDougall was awarded an Australian Laureate Fellowship commencing 2015.
- Scientia Professor Trevor McDougall has been elected as one of two vice-presidents of IPASO, the International Association for the Physical Sciences of the Oceans.

University of South Australia

- *ARC Linkage Project.* Title: Co-variant analysis and statistical modelling for improved crop yield. CIs: Professor Stanley J. Miklavcic, Dr Hamid Laga, Dr Jinhai Cai PI: Dr Haydn Kuchel. Partner Organisation: Australian Grain Technologies, Pty Ltd Amount awarded: $395,000 for the period 2015–2018.
- *ARC Linkage Project LP150100749.* Title: Improving train flows with connected driver advice systems. Investigators: Peter J. Pudney, Amie R. Albrecht, Philip G. Howlett, Scott A. Mackenzie. Industry partner: TTG Transportation Technology Pty Ltd. Amount awarded: $430,000 for the period 2015–2018.

University of Sydney

- Dr Stephan Tillmann was awarded the Faculty of Science Learning and Teaching Award.
- Mary Myerscough and Jean Yang were members of different teams that were finalists in different categories in the 2015 Eureka Prizes; for the full lists of finalists and winners see http://australianmuseum.net.au/eureka.

  Mary Myerscough was a member of The Bee team (Macquarie University and University of Sydney) which identified a mechanism for the mysterious population collapses in bee hives that have impacted honey bees worldwide. This team was a finalist, for the UNSW Eureka Prize for Scientific Research.

  Jean Yang was a member of the BioCode team (University of Sydney, CSIRO and Garvan Institute of Medical Research), which developed innovative analysis and visualisation methods that will benefit researchers in many areas of life science. This team was a finalist, for the UNSW Eureka Prize for Excellence in Interdisciplinary Scientific Research.

Appointments, departures and promotions

Australian National University

Staff departures:

- Dr Wilse Travis departed on 21 July 2015.
- Dr Katharina Neusser departed on 4 July 2015.

Staff arrivals:

- Dr Xiong Changwei, Research Fellow, arrived on 13 July 2015.
- Dr Zhang Jun, Research Fellow, arrived on 6 July 2015.

Charles Sturt University

- Professor Ken Russell has retired.
- Dr Ryan Ip has joined as a lecturer in statistics.

Flinders University

- Professor Raja Huigol retired from the school of Computer Science, Engineering and Mathematics on Friday 31 July 2015, after an impressive 40 years of distinguished service at Flinders University.

Monash University

New arrivals:

- Prof Hans de Sterck
- Associate Professor Jessica Purcell
- Dr Yann Bernard
- Dr Jane Gao

University of Melbourne

New staff:

- Professor Christian Haesemeyer
- Dr Marcy Robertson
- Dr Daniel Murfet

University of New South Wales

New staff:

- Dr Liangyi (Lee) Zhao, Senior Lecturer in Pure Mathematics. Dr Zhao has a PhD from Rutgers University, USW, and comes to UNSW from Nanyang Technological University, Singapore.
- Dr Michael Feischi comes as postdoc with Thanh Tran for five months and then with Josef Dick. Dr Feischi has a PhD from Vienna University of Technology.
- Dr Loic Thibaut comes as postdoc with David Warton. Dr Thibaut has a PhD in Marine Biology from James Cook University.

Promotions:

- Dr Pinhas Grossman has been promoted to Senior Lecturer effective 1 July 2015.

University of Sydney

- Slaven Kozic has joined the School as Postdoctoral Research Associate.
- The School welcomes Dr Anne Thomas as a Senior Lecturer.

University of Wollongong

New staff:

- Dr Bohai Zhang, a postdoc, is working with Prof Noel Cressie.

Conferences and Courses

Conferences and courses are listed in order of the first day.

IGA/AMSI workshop: Australia-Japan Geometry, Analysis and their Applications

Dates: 19–23 October 2015
Venue: The University of Adelaide
Website: http://www.iga.adelaide.edu.au/workshops/WorkshopOct2015/

Global analysis relies on combining ideas from the complementary areas of geometry and analysis. This workshop will bring together researchers from Australia and Japan with interests in these areas with the aim of building capacity both in interdisciplinary pure research and in applications.

Distinguished international speakers include:

- Professor Mikio Furuta (University of Tokyo)
- Professor Martin Guest (Waseda University)
- Professor Motoko Kotani (Tohoku University)
- Professor Yoshiaki Maeda (Tohoku University)

For more details please refer to the website.

Analysis and Geometry in non-Riemannian spaces

Dates: 2–4 November 2015
Venue: University of New South Wales
Web: http://conferences.science.unsw.edu.au/SR2015/

Non-Riemannian geometries occur in different areas of pure and applied mathematics, including rigidity of lattices, hypoelliptic differential operators, heat diffusion and wave propagation on manifolds, several complex variables, control theory, non-holonomic mechanical systems, and neurobiology. We propose to bring together researchers interested in several of these areas, to create a scientific environment for exchanging ideas and developing new interactions.

The website of the event is now online. Please follow the instructions therein to inform us of your interest to attend.

Speakers (now confirmed) include:

- Professor Xuan Duong, Macquarie University
- Professor Michael Eastwood, University of Adelaide
- Professor Tom ter Elst, University of Auckland
- Professor Rod Gover, University of Auckland

- Dr Enrico Le Donne, University of Jyväskylä
- Dr Thomas Leistner, University of Adelaide
- Dr Ji Li, Macquarie University
- Professor Gerd Schmalz, University of New England
- Dr Adam Sikora, Macquarie University
- Dr Anne Thomas, University of Glasgow
- Professor Lesley Ward, University of South Australia

Recent trends on Nonlinear Evolution Equations

Dates: 4–5 November 2015
Venue: University of Sydney
Web: http://www.maths.usyd.edu.au/u/dhauer/nonlinear-evolution/index.html

In recent years, there has been spectacular progress in the study of nonlinear diffusion equations and geometric flows. Therefore the fundamental aim of the workshop is to showcase these advances. Key challenges for the future that we target include the quantitative analysis of the dynamics of solutions arising from flows generated by deterministic, nondeterministic, and geometric evolution equations.

During the two-day workshop, talks from both communities are intertwined, serving to highlight salient ideas, proofs and questions, which are important fertile ground for pushing forward research in Australia and world-wide. In particular, this event has the intention to give PhD students and early career researchers the opportunity to meet some of the leading experts in the field of geometric evolution equations and nonlinear evolution equations. Every interested researcher is invited to attend and participate at this event.

Please use Eventbrite https://www.eventbrite.com.au/e/recent-trends-on-nonlinear-evolution-equations-tickets-18681297263 to register for this workshop if you would like to attend (free). The schedule of the days, title of the talks with abstracts can be found at the home page (see link above).

The 21st International Congress on Modelling and Simulation (MODSIM2015)

Date: Sunday 29 November to Friday 4 December 2015
Venue: Gold Coast Convention and Exhibition Centre, Broadbeach, Queensland
Web: http://www.mssanz.org.au/modsim2015/index.html

For further details see the website or *Gazette* 42(1), p. 56.

SM^2 Statistical Mechanics of Soft Matter

Dates: 30 November to 1 December 2015
Venue: Swinburne University of Technology

Further details to follow.

Australian Mathematical Sciences Student Conference

Dates: 30 November to 2 December 2015
Venue: University of Tasmania

Further details to follow.

Engineering Mathematics and Applications Conference (EMAC)

Date: 6–9 December 2015
Venue: UniSA, City West Campus Adelaide
Web: https://emac2015.unisa.edu.au/

Abstract submission is now open for EMAC 2015 and closes on 9 October. This meeting provides a forum for researchers interested in the development and use of mathematical methods in engineering and applied mathematics. It aims to foster interactions between mathematicians and engineers, from both academia and industry.

The ANZIAM/CSIRO Student Support Scheme will be available to student attendees of EMAC. Applications close 23 October.

Early-bird registration also closes on 23 October.

To register or find out more, visit the website (above).

KOZWaves 2015

Date: 6–9 December 2015
Venue: The University of Adelaide
Web: http://www.maths.adelaide.edu.au/kozwaves2015/index.html

The second international Australasian conference on wave science: see *Gazette* 42(1) p. 56 or the website for further details.

Guttmann 2015: 70 and Counting

Dates: 7–8 December 2015
Venue: Noahs on the Beach, Newcastle

Further details to follow.

Seventh China-Australia Workshop on Optimization: Theory, Methods and Applications and The Second International Conference on Optimization and Control

Date: 7–10 December 2015
Venue: Chongqing Normal University, the University Town, Chongqing 401331
Website: http://icoco2015.csp.escience.cn

39th Australasian Conference on Combinatorial Mathematics and Combinatorial Computing

Date: Monday 7 December to Friday 11 December 2015
Venue: University of Queensland
Web: http://39accmcc.smp.uq.edu.au/

Registration is now open for 39ACCMCC, which will be held at the University of Queensland, in Brisbane, Australia, from Monday 7 December to Friday 11 December 2015.

Please make sure that you register during the early-bird registration period, which ends on Sunday 1 November. All registration will close on Monday 16 November.

The invited speakers are:

- Peter Cameron (University of St Andrews and Queen Mary University of London)
- Saad El-Zanati (Illinois State University)
- Nevena Francetic (Monash University)
- Catherine Greenhill (University of New South Wales)
- Penny Haxell (University of Waterloo)
- Jonathan Jedwab (Simon Fraser University)
- Gordon Royle (University of Western Australia)
- Charles Semple (University of Canterbury)

Attendees are invited to submit an abstract for a contributed talk of 25 minutes duration (including time for questions), covering some topic in discrete or combinatorial mathematics or a related area of computer science.

Information on registration, submission of abstracts, and accommodation can all be found at the website.

Queries should be sent to Darryn Bryant db@maths.uq.edu.au.

We look forward to seeing you in Brisbane.

BioInfoSummer 2015

Date: 7–11 December 2015
Venue: The University of Sydney
Website: http://bis15.amsi.org.au/

The BIS symposium introduces bioinformatics as well as mathematical and computational biology to students, researchers and professionals. If you work in mathematics or statistics, information technology or complex systems analysis, any computer science field, or you're biological, chemical or medical sciences engineer, stay ahead with BIS.

The 2015 program features:

- Introduction to biology and bioinformatics
- Epigenomics
- Translational genomics

- Proteomics and metabolomics
- Systems biology, networks and data integration.

International speakers

- Professor Keith Baggerly (University of Texas, MD Anderson Cancer Centre)
- Professor Susan Holmes (Stanford University)
- Associate Professor Katerina Kechris (University of Colorado Denver)
- Dr Ioannis Xenarios (Swiss Institute of Bioinformatics)
- Dr Judith Zuagg (European Molecular Biology Laboratory)

National speakers

- Associate Professor Aaron Darling (University of Technology Sydney)
- Dr Richard Edwards (University of New South Wales)
- Associate Professor Neville Firth (University of Sydney)
- Dr Jerry Gao (Walter and Eliza Hall Institute of Medical Research)
- Dr Eleni Giannoulatou (Victor Chang Cardiac Research Institute)
- Professor Vanessa Hayes (Garvan Institute of Medical Research)
- Dr Joshua Ho (Victor Chang Cardiac Research Institute)
- Professor David James (University of Sydney)
- Professor Sean O'Donoghue (Garvan Institute of Medical Research)
- Professor Shoba Ranganathan (Macquarie University)
- Professor Terry Speed (Walter and Eliza Hall Institute of Medical Research)
- Professor Claire Wade (University of Sydney)
- Professor Marc Wilkins (University of New South Wales)
- Professor Sue Wilson (Australian National University)

Please register at the website.

Earlybird registration closes: 1 October 2015.
Travel Grant Applications are now open and close on 16 October 2015.
Poster abstract submissions close: 6 November 2015.
Registration closes: 27 November 2015.

Fourth ANZAMP Meeting

Dates: 9–11 December 2015
Venue: Newcastle
Web: http://www.anzamp.austms.org.au/meetings/current/

The Fourth Annual Meeting of the Australian and New Zealand Association of Mathematical Physics (ANZAMP), and the first since ANZAMP became a Division of AustMS, will be held in Newcastle from 9–11 December. Registration is now open.

We are delighted announce that the following keynote speakers will be attending.

- Mireille Bousquet-Mélou (University of Bordeaux)
- Denis Evans (Australian National University)

- Daniel Jafferis (Harvard University)
- Rod Gover (The University of Auckland)
- Kentaro Hori (IPMU, The University of Tokyo)
- Sarah Post (University of Hawaii)

For further details please see the website. In particular, the direct link for the registration page is: http://www.anzamp.austms.org.au/meetings/current/register.

Attendees are encouraged to register prior to the early registration deadline of 23 October, and to make early bookings for their accommodation and travel.

Conference on Geometric and categorical representation theory

Dates: 14–18 December 2015
Venue: Mantra Hotel, Mooloolaba, Queensland
Web: https://sites.google.com/site/masoudkomi/mooloolaba

2016 AMSI Summer School

Dates: 4–29 January 2016
Venue: RMIT University
Web: http://ss16.amsi.org.au/

The AMSI Summer School is an exciting opportunity for mathematical sciences students from around Australia to come together over the summer break to develop their skills and networks.

The four-week residential school offers eight exciting honours level subjects designed to give you the opportunity to study areas that are not available at your university. You can choose to take one or two of the subjects that are on offer and may be able to take these for credit at your home institution.

Program extras include icebreaker events, special guest lectures, careers and women in mathematics events.

- Calculus of Variations: Theory and Practice — Julie Clutterbuck and Anja Slim, Monash University
- Complex Networks — Stephen Davis, RMIT University
- Conic Programming — Vera Roshchina, RMIT University
- Design and Analysis of Experiments — Stelios Georgiou, RMIT University
- Linear Control Theory and Structured Markov Chains — Yoni Nazarathy, The University of Queensland
- Modern Numerical Methods for Diffusion Equations on Generic Grids — Jerome Droniou, Monash University
- Projective Geometry — John Bamberg, The University of Western Australia
- Stochastic Modelling — Giang Nguyen, The University of Adelaide

Remember that

- Travel Grant applications and first registration close: 1 November 2015.
- Final registration closes: 25 November 2015.

Gromov–Witten Theory, Gauge Theory and Dualities

Date: 6–15 January 2016
Venue: ANU/Kioloa
Web: http://maths.anu.edu.au/events/gromov-witten-theory-gauge-theory-and-dualities

The workshop on 'Gromov–Witten theory, Gauge Theory and Dualities' is one of the major events hosted by the 2015 MSI special year on 'Geometry and Physics'. The workshop will begin on 6 January 2016 in Canberra with an introductory workshop followed by an international conference at the ANU Kioloa campus from 10 January 2016. The introductory workshop aims to familiarise postgraduate students and young researchers to some of the main mathematical techniques for the study of the moduli spaces from gauge theory and Gromov–Witten theory. The purpose of the conference is to bring together leading international researchers in the areas of geometry and physics, with a main focus on the geometry and topology of moduli spaces arising from gauge theory and Gromov–Witten invariants, mirror symmetry and other dualities.

Introductory workshop

The introductory workshop will be held at the Australian National University from 6–9 January 2016.

Introductory mini course speakers

- Bohui Chen (geometry of moduli spaces from Gromov–Witten theory and gauge theory)
- Kenji Fukaya (Floer homology of 3-manifolds with boundary)
- Kaoru Ono (Gromov–Witten theory and mirror symmetry)
- Gang Tian (gauge theory and calibrated geometry)

International conference

The conference will be held at the ANU Kioloa Coastal Campus from 10–16 January 2016. For information on the ANU Kioloa Coastal Campus click here.

Invited speakers

- Jim Bryan (University of British Columbia)
- Bohui Chen (Sichuan University)
- Cheol-Hyun Cho (Seoul National University)
- Huijun Fan (Beijing University)
- Bohan Fang (Beijing University)
- Kenji Fukaya (Simons Centre for Geometry and Physics, Stony Brook)
- Andriy Haydys (University of Bielefeld)
- Ko Honda* (UCLA)
- Jianxun Hu (Zhongshan University)
- Hiroshi Iritani (Kyoto University)
- Jesper Jacobsen* (ENS Paris)
- Bumsig Kim (KIAS, Seoul)
- Conan Leung (Chinese University of Hong Kong)

- Xiaobo Liu (University of Notre Dame)
- Alina Marian (Northeastern University)
- Ignasi Mundet (University of Barcelona, Spain)
- Yong-Geun Oh (IBS, South Korea)
- Hiroshi Ohta (Nagoya University)
- Kauro Ono (Kyoto University)
- Yongbin Ruan (University of Michigan)
- Gang Tian (Princeton University/Beijing University)
- Rui Wang (University of California at Irvine)
- Siye Wu (National Tsing-Hua University, Taiwan)
- Aleksey Zinger* (University of New York, Stony Brook)

*To be confirmed

Organising Committee

- Peter Bouwknegt (Australian National University)
- Brett Parker (Australian National University)
- Paul Norbury (University of Melbourne)
- Bryan Wang (Australian National University), Chair

Scientific Committee

- Yakov Eliashberg
- Kenji Fukaya
- Alexander Givental
- Yongbin Ruan
- Gang Tian

Mathematics in Industry Study Group (MISG) 2016

Dates: 1–5 February 2016
Venue: University of South Australia

Further details to follow.

ANZIAM 2016

Date: Sunday 7 February 2016 to Thursday 11 February 2016
Venue: QT Canberra Hotel, Canberra
Web: http://anziam2016.com/

Registration for the 2016 Australian and New Zealand Industrial and Applied Mathematics (ANZIAM) Conference is now open. This conference is the premier annual meeting in Australia and New Zealand, where leading, as well as young, applied mathematicians gather to exchange ideas to promote and advance the application of mathematics to science, engineering and industry.

Abstract submission closes: 8 January 2016.
Early-bird registration closes: 8 January 2016.

To register and submit an abstract, or to find out further details, please visit the website.

AMSI Big Day In

Date: 10–11 February 2016
Venue: Trinity College, The University of Melbourne
Web: vrs.amsi.org.au/big-day

Further details to follow.

Capital Number Theory

Dates: 8–9 April 2016
Venue: The Australian National University

Further details to follow.

Mathematical Methods for Applications

Date: 11–14 November 2016
Venue: Hangzhou, China
Further information: Phil Broadbridge (P.Broadbridge@latrobe.edu.au)

This is a joint meeting of ANZIAM and ZAPA, the Zhejiang Applied Mathematics Association.

Visiting mathematicians

Visitors are listed in alphabetical order and details of each visitor are presented in the following format: name of visitor; home institution; dates of visit; principal field of interest; principal host institution; contact for enquiries.

Prof Dmitri Alekseevsky; Russian Academy of Sciences; 4–14 October 2015; homogeneous Riemannian geometry, Lie groups and algebras; LTU; Yuri Nikolayevsky

Dr Joel Andersson; Stockholm University; 1–31 October 2015; pure; USN; Leo Tzou

Paul Baird; Laboratoire de Mathematiques, De Bretagne Atlantique; September to December 2015; UWA; Lyle Noakes

Dr Elizabeth Beazley; Haverford College, USA; 1 August 2015 to 31 January 2016; UMB; Arun Ram

Prof Louis Chen; National University of Singapore; 10–19 September 2015; UMB; Aihua Xia

Dr Aline Aparecida de Souza Leao; University of Sau Paulo, Brazil; 1 July to 1 November 2015; UMB; Alysson Costa

Louis Guillot; Ecole Normale Superieure; 1–16 September 2015; UMB; Richard Huggins and James McCaw

A/Prof Jianyu Han; Anhui University, PRC; 1 August 2015 to 31 July 2016; UMB; Dr Guoqi Qian

A/Prof Mengbo Hou; Shandong University of China; February 2015 to February 2016; cryptography; USA; Raymond Choo

Mr He Huang; Peking University; 1 September 2015 to 31 August 2016; UMB; Sanming Zhou

Dr Bernt Jensen; Gjovik University College, Norway; 24 July 2015 to 9 January 2016; representations of algebras; UNS; Jie Du

Prof Satoshi Koike; 7 October to 7 November 2015; pure; USN; Laurentiu Paunescu

Prof Shrawan Kumar; University of North Carolina; 16 July to 15 December 2015; pure; USN; Gus Lehrer

A/Prof Jingjian Li; Guangxi University P.R. China; September 2015 to September 2017; UWA; Cai Heng Li

Zhe Liu; Zhejiang University; 1 April 2015 to 31 March 2016; UWA; Cai Heng

Johnathan Manton; University of Melbourne; 1 January to 31 December 2018; ANU; Alan Carey

Dr Djordje Milicevic; Bryn Mawr College, Pennsylvania; 1 August 2015 to 31 January 2016; UMB; Arun Ram

Prof Pierre Milman; University of Toronto; 15 October to 15 November 2015; pure; USN; Laurentiu Paunescu

Samuel Mueller; University of Sydney; 1 January to 31 December 2016; ANU

Dr Simona Paoli; University of Leicester, UK; 1 August to 31 December 2015; higher category theory; MQU; Ross Street

Dr Peter Price; 30 March 2015 to 31 December 2016; ANU; Dr Lilia Ferrario

Mr Muhamad Shoaib; Higher Education Commission, Pakistan; 1 May to 30 November 2015; statistics; USN; Shelton Peiris

Alexander Stolin; University of Gothenburg, Sweden; 7–18 August 2015; quantum groups, quantum Lie algebras, Lie bialgebras; LTU; Yuri Nikolayevsky

A/Prof Lianta Su; Quanzhou Normal University, PRC; 1 August 2015 to 31 January 2016; UMB; Guoqi Qian

Dr Xiuping Su; University of Bath; 24 July 2015 to 9 January 2016; representations of Algebras; UNS; Jie Du

A/Prof Kaibiao Sun; Dalian University of Technology, P.R. China; August 2015 to August 2016; biological system modeling, biological cybernetics, optimization theory; SUT; Tonghua Zhang

Prof Anatoliy Swishchuk; University of Calgary; 9–13 December 2015; probability theory and financial mathematics; LTU; Andriy Olenko

Dr Garth Tarr; 1 March 2015 to 31 December 2015; ANU; Alan Welsh

A/Prof Yuan Tian; Dalian University of Technology, P.R. China; August 2015 to August 2016; mathematical biology; SUT; Tonghua Zhang

Prof Ruth Williams; Univeristy of California, San Diego; 9–27 September 2015; statistics; UMB; Peter Hall

Dr Jeroen Wouters; 25 February 2015 to 24 February 2017; applied; USN; Georg Gottwald

Mr Wei Wu; UNSW; 30 July 2012 to 31 May 2016; financial maths; USN; Ben Goldys

Hui Zhou; Peking University, PRC; September 2015 to March 2017; UWA; Cheryl Praeger, Alice Devillers and Michael Giudici

AMSI 16 Summer School IN THE MATHEMATICAL SCIENCES

RMIT University
4-29 JANUARY 2016

STOCHASTIC MODELLING
Giang Nguyen, The University of Adelaide

LINEAR CONTROL THEORY & STRUCTURED MARKOV CHAINS
Yoni Nazarathy, The University of Queensland

CONIC PROGRAMMING
Vera Roshchina, RMIT University

MODERN NUMERICAL METHODS FOR DIFFUSION EQUATIONS ON GENERIC GRIDS
Jerome Droniou, Monash University

DESIGN & ANALYSIS OF EXPERIMENTS
Stelios Georgiou, RMIT University

COMPLEX NETWORKS
Stephen Davis, RMIT University

CALCULUS OF VARIATIONS: THEORY & PRACTICE
Julie Clutterbuck, The Australian National University & Anja Slim, Monash University

PROJECTIVE GEOMETRY
John Bamberg, The University of Western Australia

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Research

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AUSTRALIAN MATHEMATICAL SCIENCES INSTITUTE

The Alf van der Poorten Travelling Fellowship 2015

The Alf van der Poorten Travelling Fellowship for 2015 has been awarded to Dr Tri-Thang Tran of the University of Oregon, who obtained a PhD from the University of Melbourne in December 2014.

Special Interest Meeting deadlines

The deadline for the next round of Special Interest Meetings is 26 November 2015.

AustMS Accreditation

Mr S.G. McAndrew, of Trinity Grammar School Summerhill, has been accredited as an Accredited Member (MAustMS).

The following members have been accredited as Fellows (FAustMS):

- Professor G. Auchmuty of the University of Houston;
- Professor A.R. Francis of the University of Western Sydney;
- Professor J.F. Grotowski of the University of Queensland;
- Professor J.H. Manton of the University of Melbourne;
- Professor E. Platen of the University of Technology, Sydney;
- Professor K.C. Stacey of the University of Melbourne.

Peter Stacey
AustMS Secretary
Email: P.Stacey@latrobe.edu.au

Peter Stacey joined La Trobe as a lecturer in 1975 and retired as an associate professor at the end of 2008. Retirement has enabled him to spend more time with his family while continuing with some research and some work on secondary school education. He took over as secretary of the Society at the start of 2010.

The Australian Mathematical Society

President:	Professor Tim Marchant, FAustMS	Dean of Research University of Wollongong NSW 2522, Australia. tim_marchant@uow.edu.au
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Business Manager:	Ms May Truong	Department of Mathematics Australian National University Acton, ACT 0200, Australia. office@austms.org.au

Membership and Correspondence

Applications for membership, notices of change of address or title or position, members' subscriptions, correspondence related to accounts, correspondence about the distribution of the Society's publications, and orders for back numbers, should be sent to the Treasurer. All other correspondence should be sent to the Secretary. Membership rates and other details can be found at the Society web site: www.austms.org.au.

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ISSN: 0311-0729

Published by The Australian Mathematical Publishing Association Incorporated
Typeset in Australia by TechType, ACT
Printed in Australia by Union Offset Printers, ACT