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Gazette

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- 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

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Notes for contributors

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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 43(3), 43(4) and 43(5) of the *Gazette* are 1 June, 1 August and 1 October 2016.

Volume 43 Number 2 2016

Editorial

David and I welcome you to the May, 2016 issue of the *Gazette*. As a Federal election has been called for July 2, this Editorial must be apolitical. Let us hope that after the election the new government will address funding for universities, funding for research, and attraction of mathematically capable students into high school mathematics teaching careers. Tim Marchant in his President's Column says 'World class research activity requires international collaboration and grants and travel money are both key to supporting these types of research links.' He also refers to the ACOLA review of Australia's research training system and says: 'The final report ... makes recommendations regarding industry involvement in HDR training and the value of industry placements. In particular ... every candidate who wishes to undertake an industry placement should be encouraged to do so. The Mathematical Sciences are well placed in this endeavour due to existing programs such as ASMI Intern and also the Mathematics in Industry Study Group. However, the scale of placements needed to satisfy student demand is likely to very large and hence challenging to implement.' Tim also makes mention of the film 'The Man Who Knew Infinity' which was recently released in Australia and is about the life of Ramanujan. Fields Medallist Manjul Bhargava, an invited speaker at AustMS 2015, was an Associate Producer of the film.

Peter Forrester is the new Chair of the National Committee for the Mathematical Sciences. Peter refers to the work of the outgoing Chair of NCMS, Professor Nalini Joshi, 'who was responsible for a number of transformational initiatives, as brought about by her tireless advocacy for the role of the Mathematical Sciences in securing Australia's future, and her active addressing of the under-representation of women in our discipline. ... Nalini initiated the Australian Academy of Science Decadal Plan, by raising funds to support the process, formulating a structure to proceed and remaining throughout as one of the three members of the Decadal Plan Steering Committee, chaired by the late Professor Peter Hall, another champion of Australian Mathematical Sciences. The decadal plan was launched at Parliament House on March 17th. ... The report asks the National Committee for the Mathematical Sciences to formally monitor the progress on the plan.'

Geoff Prince, Director of AMSI writes 'On April 14th the Minister for Education and Training, Simon Birmingham, announced $2m in co-funding over four years for AMSI's research training programs. This renewal of the 2012–2016 grant is a testament to our success for which I acknowledge all the hard work of AMSI members in hosting events, teaching courses and supervising students. Simi Henderson, AMSI's program manager for research and higher education, also deserves

our warm thanks and congratulations. We are reproducing the Executive Summary of our renewal application in the interests of *Gazette* readers so that you can see what AMSI has planned for the period 2016–2020.'

Peter Stacey, Secretary of AustMS, announces in this issue the 'Election of officers and ordinary members of Council'. If you have interest in contributing direct to AustMS, please consider nominating for available positions.

In this issue of the Gazette there is an Obituary for J. P. O. (Phil) Silberstein who was a founding member of AustMS, and Professor of Pure Mathematics at the University of Western Australia from 1966 until his retirement in 1985.

In this issue we record 'Professor Hugh Possingham's sustained top-level leadership and research contributions in Mathematics and Ecology have very recently been recognised with two significant honours ... The U.S. National Academy of Sciences elected Hugh Possingham as a Foreign Associate at its recent Annual Meeting. Foreign associates are non-voting members of the Academy, elected in recognition of their distinguished and continuing achievements in original research.' Hugh has also been appointed chief scientist with The Nature Conservancy, one of the world's largest conservation groups.

The ANZIAM medal has been awarded to Frank Robert de Hoog (or simply Frank to colleagues and friends) who 'epitomises a worthy recipient of the ANZIAM medal because his contributions to applied, computational and industrial mathematical research are nationally and internationally famous, while his contributions to ANZIAM have had a significant impact especially in the development of the student support scheme.' For a description of his contributions, read the article in this issue.

The J.H. Michell Medal is awarded by ANZIAM in honour of John Henry Michell to an outstanding new researcher, within 10 years of their PhD, who has carried out distinguished research in applied and/or industrial mathematics, and where a significant proportion of the research work has been carried out in Australia and/or New Zealand. The Medal has been awarded to 'Associate Professor Joshua Ross from the University of Adelaide. Joshua has made significant contributions to methodology in Applied Mathematics and, through its application, to conservation biology and public health policy.'

This issue contains solutions and announces prize-winners for the final two Puzzle Corners, numbers 44 and 45. We are no longer asking you to submit solutions to puzzles. Instead, we are asking you now to submit puzzles for solution. Norman Do, Chair of the Australian Mathematical Olympiad Senior Problems Committee, is asking for problems suitable for mathematics competitions, including the International Mathematical Olympiad. See his article for details, and example of problems submitted by Australian mathematicians to various competitions.

The May issue of the *Gazette* also contains reports on Workshops and four book reviews. And as usual it has News from across Australian universities. In particular, this includes comings and goings, completed PhDs and visitors.

We hope you enjoy this issue.

Sid Morris, Adjunct Professor, La Trobe University;
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Sid Morris retired after 40 years as an academic. He received BSc (Hons) from UQ in 1969 and PhD from Flinders in 1970. He held positions of Professor, Department Head, Dean, Deputy Vice-Chancellor, CAO and CEO. He was employed by the universities: Adelaide, Ballarat, Flinders, Florida, La Trobe, UNE, UNSW, UQ, UniSA, Tel-Aviv, Tulane, Wales, and Wollongong. He was Editor of *Bull. AustMS* and *J. Research and Practice in IT*, and founding Editor-in-Chief of *AustMS Lecture Series*. He has been on the Council of AustMS for 20+ years and its Vice-President. He received the Lester R. Ford Award from the Math. Assoc. America. He has published 150 journal papers and 4 books for undergrads, postgrads and researchers, plus an online book, translated into 7 languages and supplemented by YouTube videos and a Facebook group of 4,000+ members. The third edition of his 900-page book *The Structure of Compact Groups* with Karl H. Hofmann was published in 2013. In 2016 he received ordination as a Rabbi and also became a grandfather.

President's Column

Tim Marchant*

I have recently returned from a nonlinear optics conference held in southern Mexico. It was pleasant to catch up on the latest research developments in an exotic location but my colleagues reported a number of worrying trends which will be familiar to researchers in Australia. Firstly the number of delegates attending the meeting was much lower than in previous years, due to the difficulty in sourcing travel money. Secondly, there were many reports that competitive research grants were becoming harder to get with success rates for some schemes much less than 10%. World class research activity requires international collaboration and grants and travel money are both key to supporting these types of research links. Of course, there are no easy solutions to these issues which will probably persist for a long period of time. The Australian sector is better off than many other places, due to the funding that flows from our strong international student market. However, on the flip side, it is much more costly for us visit our international collaborators, due to the tyranny of distance.

The 2016 Science Meets Parliament was held in early March. The two AustMS representative were Prof. Troy Farrell, QUT, and myself. SMP brings together over 100 scientists, from a vast range of professional societies, for two days of presentations and a small group meeting with a MP. I particularly enjoyed the talks by Prof. Brian Schmidt, now VC at the ANU and the Australian Chief Scientist, Dr Alan Finkel. I spoke to two Labor backbenchers during the event and listened to presentations by both Bill Shorten and Christopher Pyne. All expressed very positive sentiments about Science and Technology. It seems that most aspects of government policy in this area have bipartisan support. Two common and clear themes were expressed by everyone associated with SMP; the growing importance of university interaction with industry and the need to support more female scientists in Australia to achieve senior career positions.

In one of my columns last year I discussed the ACOLA review of Australia's research training system. The final report has now been released and it makes recommendations regarding industry involvement in HDR training and the value of industry placements. In particular it states that every candidate who wishes to undertake an industry placement should be encouraged to do so. The Mathematical Sciences are well placed in this endeavor due to existing programs such as ASMI Intern and also the Mathematics in Industry Study Group. However the scale of placements needed to satisfy student demand is likely to very large and hence challenging to implement. For example, HDR supervisors may need to develop

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new industry relationships and links in order to offer suitable placements to their students.

The film 'The Man who Knew Infinity' is to be released in Australia in early May. It concerns the life of Ramanujan who gains admittance to Cambridge University during World War I and studied with G.H. Hardy. Prof. Manjul Bhargava, Fields Medalist and invited speaker at AustMS 2015, was an Associate Producer for the film, so I assume that the presentation of the mathematics is reasonably authentic. There are not many films made about mathematics and fewer still with well known stars (Jeremy Irons plays Hardy) so this one may be worth a look.

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*

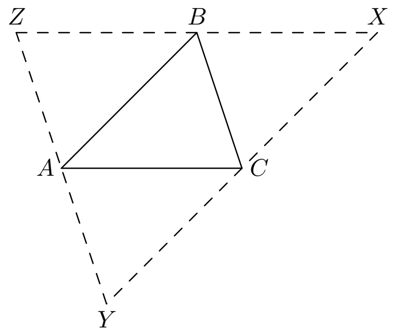
Solutions to Puzzle Corner 44

Many thanks to everyone who submitted. The $50 book voucher for the best submission to Puzzle Corner 44 is awarded to Joe Kupka. Congratulations!

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*.*

Solution by Dave Johnson: Let the triangle with the largest area be ABC. Construct a line through A which is parallel to BC, a line through B which is parallel to AC, and a line through C which is parallel to AB. Let the resulting larger triangle be XYZ as shown in the diagram below.



Consider any other point D in the set. Since the area of ACD must be smaller than or equal to the area of ABC, the point D must lie below the line XZ. Similarly, the point D must lie to the right of the line YZ and to the left of the line XY. Therefore the point D must lie inside triangle XYZ. Since this argument holds for any point D in the set, it follows that the entire set of points must lie within triangle XYZ. Finally, since the area of XYZ is exactly four times the area of ABC which is no more than 1, the entire set of points must lie within a triangle whose area is at most 4, as required.

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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Solution by Joe Kupka: For convenience, suppose the pizza has a total area of 4. First note that for any given direction, it is possible to draw a *half-line* in that direction which divides the pizza into two pieces of equal area. This can be achieved by shifting the line sideways and applying the intermediate value theorem. Now draw a horizontal half-line and a vertical half-line. They will divide the pizza into four pieces. Let the top right piece have area $1 + a$, then the top left piece must have area $1 - a$. Let $f(0) = 1 + a$.

Now for $\theta \in (0, \pi/2)$, define $f(\theta)$ in a similar fashion. Draw a half-line which forms an anti-clockwise angle of θ with respect to the horizontal direction, and another half-line which forms an anti-clockwise angle of θ with respect to the vertical direction. The two half-lines again divide the pizza into four pieces. Let $f(\theta)$ be the area of the piece which extends upwards indefinitely. Finally, define $f(\pi/2) = 1-a$.

Roughly speaking, as θ varies from 0 to $\pi/2$, $f(\theta)$ is the area of the pizza within a rotating quadrant. We claim f is a continuous function on $[0, \pi/2]$. Indeed, since the pizza is bounded, it is contained within a circle of diameter d. It is easy to check that

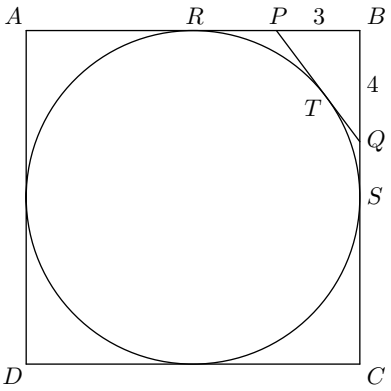
$$|f(\theta + h) - f(\theta)| \leq hd^2,$$

which implies continuity. By the intermediate value theorem, there exists an angle $\theta \in [0, \pi/2]$ such that $f(\theta) = 1$. Therefore the half-lines at that value of θ cut the pizza into four pieces of equal area, as required.

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?

Solution by Alan Jones: Let the midpoint of AB and BC be R and S respectively. Let the tangent point of PQ with the circle be T.



Since the two tangents from a point to a circle have equal length, we have the following equalities:

$$BR = BS, \qquad PR = PT, \qquad QT = QS.$$

Combining them with the fact that BR and BS equal to the radius r, we obtain:

$$\begin{aligned} 2r = BR + BS &= BP + PR + BQ + QS = BP + PT + TQ + QB \\ &= BP + PQ + QB = 3 + 5 + 4 = 12. \end{aligned}$$

Hence the required radius is given by $r = 6$.

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?

Solution by Joe Kupka: Yes it is possible. Divide them into two groups in a way which maximises the number of inter-group friendships. This is possible since the number of ways to divide everyone into two groups is finite. Now consider any person P. Suppose that less than half of P's friends are in the opposite group. But then we can simply move P to the opposite group to increase the total number of inter-group friendships. This is a contradiction. Thus at least half of Ps friends are in the opposite group in the first place. Since this holds for any person P, the required condition is therefore satisfied.

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?*

Solution by Jensen Lai: (i) If n is even, the board can be divided into 1×2 blocks. Every time Amy marks one square of a 1×2 block, Bob can then mark the second square of the same block. This is a winning strategy for Bob as he will always have an available adjacent square to mark.

Now consider the case where n is odd. After Amy marks one of the corner squares, the rest of the board can once again be divided into 1×2 blocks. This time the roles are reversed. After Amy's first move, whenever Bob marks one square of a 1×2 block, Amy can then mark the other square of the same block. So in this case, Amy has the winning strategy.

(ii) If n is even, Bob can still use the winning strategy from part (i). If n is odd, Bob has a winning strategy as well in this case. Suppose Amy's first move is marking a square X adjacent to a corner square Y. By using a simple parity argument (chessboard colouring), Amy will never be able to mark Y. So Bob can simply pretend that he has already marked Y just before Amy's first move on X. Now Bob can use Amy's winning strategy from part (i) to guarantee a win.

Solutions to Puzzle Corner 45

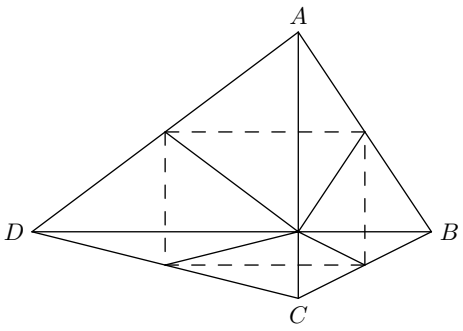
Many thanks to everyone who submitted. The $50 book voucher for the best submission to Puzzle Corner 45 is awarded to Jensen Lai. Congratulations!

Folding quadrilaterals

Find all quadrilaterals such that it is possible to fold all the corners neatly into a common point with no gaps or overlaps.

Solution by Alan Jones: This is possible if and only if the diagonals of the quadrilateral are perpendicular. Let the quadrilateral be $ABCD$. In order to fold the points A and B onto the same point, the two folds must both pass through the midpoint of AB. Similarly, the same argument applies for the midpoint of BC. Hence when folding the corner B, the fold line must be the line joining the midpoints of AB and BC. After the fold, the corner B will coincide with the foot of perpendicular from B to AC. Using the same argument, the corner D will be folded onto the foot of perpendicular from D to AC. Since B and D must be folded onto the same point, AC must be perpendicular to BD.

It suffices to check that this is possible for all quadrilateral whose diagonals are perpendicular. This is indeed possible by folding all four corners to the intersection of the diagonals.



Note that these folds are possible even if the quadrilateral is not convex. This can be done by first folding the three non-reflex corners onto the intersection of the diagonals, then folding that common point onto the reflex angle.

Summing strategy

There are 100 cards arranged in a row on the table. Each card is showing a positive integer. Two players now play a game. On each player's turn it is permitted to take either the rightmost or the leftmost card. This is done until all cards are taken. The winner is the player who has the greatest sum of numbers on his/her cards.

It is known that the sum of all cards equals 2015. Who has a winning strategy?

Solution by Dave Johnson: The first player has a winning strategy. Colour the cards so they alternate between red and blue. Now sum all the red cards and all the blue cards separately. The two sums must be different since the total sum is odd. Without loss of generality, suppose the red sum is greater. The first player can win by taking a red card every turn. This is possible since there is always an even number of cards just before the first player's move and thus the two end cards always have different colours. On the other hand, the second player must always take a blue card since both available end cards are always blue. When the game finishes the first player has all of the red cards and the second player has all of the blue cards. Therefore the first player wins since the red sum is greater than the blue sum.

Train tracks

Terrence is playing with toy train tracks and has constructed a closed circuit which contains no intersections and no linear segments. He used a large number of congruent standard rails, each having the shape of a quarter of a circle. Prove that the total number of tracks used is a multiple of 4.

Solution by Jensen Lai: Let the radius of curvature of the tracks be 1 unit. Suppose the circuit starts at the origin of a Cartesian plane and the first track begins by travelling vertically in the direction of the positive y axis. Each track toggles the direction of the circuit between vertical and horizontal. Therefore, if the circuit returns to the origin in the vertical direction, there must be an even number of tracks.

Now split the circuit into pairs of adjacent tracks. If a pair of tracks both turn in the same direction, clockwise or anticlockwise, then they form a U shape. Each U shape toggles the direction of the circuit between up and down. However, a U shape does not alter the y value of the circuit. If a pair of tracks turn in opposite directions, they form an S shape. Each S shape toggles the y value of the circuit between 0 (mod 4) and 2 (mod 4). However, an S shape does not alter the direction of the circuit. In order for the circuit to return to the origin in the starting direction, there must be an even number of S pairs and an even number of U pairs. Therefore, the total number of tracks is a multiple of 4.

Card array

Prove that if you deal out a standard deck of 52 cards into 4 rows of 13, then it is always possible to pick one card from each column to obtain 13 different card values. Note that the 13 cards do not have to have the same suit.

Solution: The solution uses Hall's marriage theorem, which is as follows. *Let there be n women and n men. For each woman, there is a subset of the men, any one of which she would happily marry; and any man would be happy to marry a woman who wants to marry him. For every subset S of women, let $f(S)$ be the subset of men whom at least one of the women would be happy to marry. If $|S| \leq |f(S)|$ holds for every subset S of women, then there it is possible to form n pairs of happily married couples.*

In the current problem, let there be 13 men denoted by the card values $A, 2, 3, \ldots, 10, J, Q, K$. Let there be 13 women corresponding to the 13 columns of the card array. For each woman, let the cards in the corresponding column represent the men whom she is happy to marry. We now check that the condition of Hall's marriage theorem is satisfied. Indeed, in any subset of k columns, there are $4k$ cards. There must be at least k different card values present in these $4k$ cards, as there are at most four occurrences of the same card value. Therefore Hall's marriage theorem can be applied here, pairing each column to a different card value contained within the column. This completes the solution.

Droid drivers

Larry and Rob are two robots travelling in a car from Arcadia to Zooland. Both robots have control over the steering and steer according to the following algorithm: Larry makes a 90° left turn after every l kilometres; Rob makes a 90° right turn after every r kilometres, where l and r are positive integers. In the event of both turns occurring simultaneously, the car will keep going without changing direction. Given that the robots started from Arcadia facing the correct direction towards Zooland, for which choices of the pair (l, r), are they guaranteed to reach Zooland, regardless of how far it is?

Solution: If $\gcd(l, r) = g > 1$, then we can scale the variables in the problem by a factor of g. So it suffices to focus on the case where $\gcd(l, r) = 1$. We claim the car will always be able to reach Zooland if and only if $l \equiv r \pmod 4$. Note that the coprime condition implies that both l and r are either 1 or 3 $\pmod 4$.

For simplicity, we will position Arcadia at $(0, 0)$ and Zooland at $(d, 0)$, so the car starts out facing east. Let us consider the path of the car in *sections* of lr kilometres. It is clear that the car will have identical behaviour for each section.

First, let us eliminate the cases where $l \not\equiv r \pmod 4$.

- $l - r \equiv 2 \pmod 4$: After the first section, we have made l left turns and r right turns, which is equivalent to a net of two right turns. Let the displacement vector for the first section be (x, y). Since the car has rotated 180°, the displacement vector for the second section will be $(-x, -y)$, which will take it back to $(0, 0)$ and the car will be facing east again. We have returned

to the starting configuration and the car has certainly never travelled further than $2lr$ kilometres from the origin. Hence it is not possible to reach Zooland if $d > 2lr$.

- $l - r \equiv 3 \pmod 4$: After the first section, we have made a net of one right turn. Let the displacement vector for the first section be (x, y) again. This time the car has rotated $90°$ clockwise. We can see that the displacement vectors for the second, third and fourth section will be $(y, -x)$, $(-x, -y)$ and $(-y, x)$ respectively. So after four sections, we are back at $(0, 0)$ and facing east again. Hence it is not possible to reach Zooland if $d > 4lr$.
- $l - r \equiv 1 \pmod 4$: This is similar to the previous case.

This leaves us with the case of $l \equiv r \pmod 4$. Here the car makes a net turn of $0°$ after each section of lr kilometres, and so it must be facing east. In order to reach Zooland, the card must traverse the entire positive x axis. We claim that the car will be at $(1, 0)$ after one section. Denote the kth kilometre of movement by m_{k-1}, which takes values from the complex numbers $1, i, -1$ or $-i$, depending on the direction. It suffices to prove $\sum_{k=0}^{lr-1} m_k = 1$.

For $l \equiv r \equiv 1 \pmod 4$. Define the following sequences for $k = 0, 1, 2, \ldots, lr - 1$:

$$p_k = (-i)^{k-\lfloor k/l \rfloor}, \qquad q_k = i^{k-\lfloor k/r \rfloor}.$$

In particular, p_k is a sequence with period l and the first l terms are $1, -i, -1$, $i, \ldots, 1$, while q_k is a sequence with period r and the first r terms are $1, i, -1, -i$, $\ldots, 1$. Furthermore, the product $p_k q_k$ also equals to the movement of the car m_k:

$$p_k q_k = (-i)^{k-\lfloor k/l \rfloor} \times i^{k-\lfloor k/r \rfloor} = i^{\lfloor k/l \rfloor} \times (-i)^{\lfloor k/r \rfloor} = m_k.$$

This holds as $\lfloor k/l \rfloor$ and $\lfloor k/r \rfloor$ are the exact number of left and right turns before the $(k + 1)$th kilometre.

Using the fact that p_k, q_k are periodic, we have $m_k = p_{(k \bmod l)} q_{(k \bmod r)}$. As l and r are coprime, by the Chinese Remainder Theorem, there is a bijection between pairs $(k \bmod l, k \bmod r)$ and the numbers $k = 0, 1, 2, \ldots, lr - 1$. Hence we have:

$$\sum_{k=0}^{lr-1} m_k = \sum_{k=0}^{l-1} p_k \sum_{k=0}^{r-1} q_k = (1 - i - 1 + i + \cdots + 1)(1 + i - 1 - i + \cdots + 1) = 1$$

as required.

For $l \equiv r \equiv 3 \pmod 4$, the same argument can be applied but with slightly different definitions of p_k and q_k:

$$p_k = i^{k+\lfloor k/l \rfloor}, \qquad q_k = (-i)^{k+\lfloor k/l \rfloor}.$$

Once again we have $\sum_{k=0}^{lr-1} m_k = \sum_{k=0}^{l-1} p_k \sum_{k=0}^{r-1} q_k = 1$.

So we have proven that, after a section of lr kilometres, the car is indeed at $(1, 0)$ facing east. In fact, the car has traversed the entire line segment joining $(0, 0)$ and $(1, 0)$ in its first move of the section. Therefore, given $l \equiv r \pmod 4$, the car will reach Zooland by the time (most likely before) it has travelled $\lfloor d \rfloor lr + 1$ kilometres.

Ivan is a Research Fellow at Monash University. 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.

Communications

Honours for Hugh Possingham

Professor Hugh Possingham's sustained, top-level leadership and research contributions in Mathematics and Ecology have very recently been recognised with two significant honours.

Foreign Associate, U.S. National Academy of Sciences

The U.S. National Academy of Sciences elected Hugh Possingham as a Foreign Associate at its recent Annual Meeting. Foreign associates are non-voting members of the Academy, elected in recognition of their distinguished and continuing achievements in original research. For the full announcement of all 84 new members and 21 foreign associates see http://www.nasonline.org/news-and-multimedia/news/may-3-2016-NAS-Election.html.

Chief scientist with The Nature Conservancy

Professor Hugh Possingham has been appointed Chief Scientist with The Nature Conservancy, one of the world's largest conservation groups. He will lead the work of more than 600 scientists engaged in conservation efforts across 69 countries around the world, including Australia. For further details see http://www.nature.org/newsfeatures/pressreleases/dr-hugh-possingham-named-chief-scientist-of-the-nature-conservancy.xml.

Hugh is a Fellow of the Australian Academy of Science, and a member of the Wentworth Group of Concerned Scientists. He is currently Australian Research Council Laureate Fellow and director of The Centre for Biodiversity and Conservation Science at the University of Queensland. He is also director of the Australian Research Council Centre of Excellence for Environmental Decisions and the Australian Government's National Environmental Science Program Threatened Species Recovery Hub. The Marxan software developed by his team drove the rezoning of the Great Barrier Reef Marine Park, and is now used in more than 150 countries.

ANZIAM Awards

Detailed Citation for Frank Robert de Hoog's Award of the ANZIAM Medal

Frank Robert de Hoog (or simply Frank to colleagues and friends) epitomises a worthy recipient of the ANZIAM medal because his contributions to applied, computational and industrial mathematical research are nationally and internationally famous, while his contributions to ANZIAM have had a significant impact especially in the development of the student support scheme.

Contributions to Applied, Computational and Industrial Mathematics Research

Frank de Hoog commenced his studies at the University of Western Australia in 1966 and graduated with first class honours in Mathematics in 1970. It was clear to his lecturers that he was gifted mathematically. During this period, his interest in applied and computational mathematics was greatly influenced by Professor J.J. Mahoney FAA, Dr Neville Fowkes and Dr Jack Williams who introduced him to applied and computational mathematics. In fact, he started a PhD at the University of Western Australia on the numerical solution of ordinary differential equations under the supervision of Dr Williams. However, with Dr Williams' return to the UK, Frank accepted a PhD scholarship at the Australian National University to work with Professor M.R. Osborne FAA on the numerical solution of ordinary differential equations. Because of the work that Richard Weiss was pursuing under the supervision of Bob Anderssen, Frank switched his focus to the numerical solution of integral equations. In hindsight, this change proved to be very important because of the success with which he, in collaboration with Richard Weiss, solved a number of important open problems.

As a direct result of the high regard that the research he performed as a PhD student established for him internationally, he was offered an Assistant Professorship in Mathematics at UCLA. With Richard Weiss at CALTECH, their research turned to the very challenging problem of the numerical analysis of singular ordinary differential equations. The resulting publications, because they resolved key issues that others working in the area had failed to resolve, immediately established international reputations for both as numerical analysts, and opened doors to an appointment for Richard Weiss in Vienna and to a return to the ANU for Frank de Hoog. Before accepting his position at CSIRO's Division of Mathematics and Statistics, he returned to earlier interests in integral equations and commenced his collaboration with his PhD student John Paine and Bob Anderssen on the numerical determination of the eigenvalues of ordinary differential equations.

The result that a simple algebraic correction formula could account for the differences between the algebraic estimates and the actual differential eigenvalues was a startling new result, the proof of which involved technically challenging and complex considerations. It has greatly influenced the subsequent design of algorithms for the computation of differential eigenvalues.

It was the significance, depth and breadth of this research which led to Frank being awarded the Australian Mathematical Society's Medal in 1988.

It was Frank's move to CSIRO that restimulated his strong interest in applied and industrial mathematics. From that point on, his research has had a very strong applied and industrial mathematical, as well as computational, impact. The success of that research has been recognized by his fairly rapid promotion to a Chief Research Scientist position on the basis of scientific merit, and his recent appointment as CSIRO Fellow. The impressive fact about this research is its phenomenal breadth, ranging over a very broad spectrum of subjects in both applied and computational mathematics, as well as its non-trivial depth and penetrating mathematical insight. There are many highlights in the research that Frank has undertaken during his more than 35 years with the CSIRO. Some, but not all, significant examples include:

(i) *Laplace Transform Inversion.* For many constant coefficient differential equations which arise in applications, it is relatively simple to determine the Laplace transform of the solution. The numerical inversion of such transforms is a very popular topic in numerical analysis and, thereby, a very challenging area in which to make a contribution that now has a science citation index score of more than 593. In part, this relates to the fact that Frank's contribution is the basis for standard algorithms in numerical analysis libraries including IMSL.

(ii) *Smoothing Spline Optimization.* The major limitation of the early methods for data smoothing with splines was the complexity of the computation of the regularization using cross-validation. In this research, it was shown how to reduce the complexity from an order n-squared activity to an order n deliberation. It is now the basis for all standard algorithms for smoothing spline fitting to observational data.

(iii) *Fast Methods for Toeplitz Matrices.* Various authors have proposed ways to exploit the special structure of a Toeplitz matrix in order to derive fast algorithms. It was a very competitive subject that required deep mathematical understanding and insight to identify an alternative strategy which improved on the earlier alternatives. Though other methods were proposed, it was the first stable numerical method for positive definite Toeplitz matrices.

(iv) *Mineral Separation.* In designing an industrial device, it is not only a matter of engineering but of matching the engineering to the operational parameters of the device. Dr de Hoog developed a mathematical model for the Kelsey Centrifugal Jig of Geologics which allowed such matching to be performed. As a result of this collaboration, these jigs are now used around the world to perform mineral separation that was not possible in the past. These jigs

are responsible for the recovery of minerals with a value in excess of half a billion dollars a year.

(v) *Sheet Metal Rolling.* The efficient production of sheet metal is a highly competitive situation. The faster the rolling can be performed, the higher the profits. However, the faster the rolling the more sophisticated must be the algorithms controlling the operation of the rolling. The work that Dr de Hoog and colleagues have accomplished has given BHP a competitive edge internationally.

(vi) *Mode Coupling in the Vibration of Beams and Shells.* The mode coupling that occurs in beams and shells is quite complex, and the earlier publications that aimed to explain this phenomenon were complex and cumbersome. The importance of this work is that it identified the key issues involved in a way that yielded a clear simple explanation.

(vii) *Conditioning and Dichotomy of Boundary Value Problems.* This research established for the first time that there are uncoupled boundary conditions that have similar conditioning to the most general situations. It thereby laid a theoretical framework for the formulation of robust algorithms for two-point boundary value problems.

Contributions to Industrial Mathematics Study Groups

In addition to the above contributions, it is important to acknowledge that Frank played a key role, along with others, in the successful establishment of the Mathematics-in-Industry Study Group Meetings, which are now an important part of the R&D image of ANZIAM. The first Study Group Meeting was organized by the then CSIRO Division of Mathematics and Statistics, with Noel Barton and Frank playing lead roles along with strong support from Kerry Landman and Terry Speed. The Study Group's successful implementation would not have been achieved with the speed and impact that it has if it were not for the dedicated and insightful commitment of Frank, Noel, Kerry and Terry, as well as others.

In many ways, one of Frank's great personal characteristics, which is the basis for his highly successful collaborative research endeavours, is his understanding, fair and unselfish approach to colleagues. An example is his work on the winding of coils, which arose initially through the Mathematics-in-Industry Study Group framework. In collaboration with CSIRO and industrial colleagues, he developed and applied theory which established explicitly the winding stress required to achieve specified residual stresses in the wound coils. As an immediate consequence of such endeavours, the damage due to excess stress was minimized while the stability of the wound coil was maximized. These results have become the basis for the processing of coils in both the aluminium (Comalco) and steel industries (BHP/Blue Scope), and contributed directly to the cost-efficiency with which aluminium and steel sheets are now rolled and coiled.

Contributions to ANZIAM

Frank has been a regular attendee since 1976 invariably giving a talk. He was a key organizer for the meeting in Merimbula in 1984.

As an extension of his strong support for students in CSIRO, in terms of student support schemes and internship programs, Frank garnered financial support for ANZIAM from CSIRO on the understanding that the funds would be exclusively used to support student participation at ANZIAM. This has turned into the CSIRO-ANZIAM Student Support Scheme and has become a feature of AustMS conferences as well as those of ANZIAM.

The Selection Committee unanimously agreed that, for all these contributions, Frank de Hoog be awarded the ANZIAM Medal for 2016.

2016 J.H. Michell Medal

The J.H. Michell Medal is awarded by ANZIAM in honour of John Henry Michell to an outstanding new researcher, within 10 years of their PhD, who has carried out distinguished research in applied and/or industrial mathematics, and where a significant proportion of the research work has been carried out in Australia and/or New Zealand.

The committee (Harvi Sidhu, Matthew Simpson and Yvonne Stokes) is unanimous in recommending that the 2016 J.H. Michell Medal be awarded to Associate Professor Joshua Ross from the University of Adelaide. Joshua has made significant contributions to methodology in Applied Mathematics and, through its application, to conservation biology and public health policy.

Joshua completed his undergraduate and postgraduate education at the University of Queensland: a Bachelor of Arts (Economics) in 2002, a Bachelor of Mathematics & Statistics in 2003, a Graduate Certificate in Higher Education in 2006 and his PhD in Mathematics in 2007. After a year as a post-doctoral research fellow in the Mathematics Institute, The University of Warwick, Joshua went to the University of Cambridge as a Zukerman Junior Research Fellow at King's College (October 2007 to March 2010). In March 2010 he joined the School of Mathematical Sciences, The University of Adelaide, as a Lecturer. He was promoted to Senior Lecturer in 2013 and to Associate Professor in 2015.

Joshua has accrued an impressive list of accomplishments. Over the last five years he has had three successful ARC Discovery Projects (one as a sole applicant), a Royal Society International Exchanges Scheme grant, and an NHMRC grant for the Centre of Research Excellence in Policy Relevant Infectious Disease Simulation and Mathematical Modelling. He was awarded an ARC Future Fellowship for 2013–2017. He is also a contributor to the Data to Decisions Cooperative Research Centre established in 2014 through which he has a project grant. In 2013 he received an Australian Institute of Policy and Science Young Tall Poppy Award.

The success Joshua has had with grants and awards bears witness to the quality and impact of his research. Joshua has a strong publication record of 45 journal articles, 7 as sole author, and he has papers in a number of high-quality journals including *The Proceedings of the Royal Society A, The Journal of Theoretical Biology* and *Global Change Biology*. In 2006 he had a sole-authored paper in *Science*.

Scopus reports 290 citations of his work in separate documents. A paper from his first post-doctoral position was selected as a 'Technological Advance' by the Faculty of 1000 Biology — a panel of over 2300 world leading biological researchers who identify research of other scientists which they believe to be particularly interesting or important.

Joshua's work, from his PhD and onwards, is noted for novel methodologies. The four key papers (of ten) arising from his PhD studies have collectively attracted 88 citations to date. Highlights from his work as a Zukerman Junior Research Fellow include:

- the fusing of network moment-closure methods with the theory of diffusion approximation to establish the first analytical understanding of the impact of network structure and stochasticity in disease dynamics, in the process providing a probabilistic explanation of the standard pair moment-closure approximation which is widely used in mathematical epidemiology, and
- the development of a suite of novel methods for the efficient evaluation of several epidemiologically relevant quantities for stochastic households models.

Since then he has been the first to publish methods for evaluating the basic reproduction number and the full distribution of the number of secondary infections, accounting for finite population size and stochastic effects (*Journal of Theoretical Biology*, 2011, sole author). Another highly innovative contribution, which exemplifies the novelty of Joshua's work, is his paper published in *Ecological Modelling* in 2013 which combined methods from Applied Mathematics with the theory of Optimal Experimental Design, to determine the optimal use of state-of-the-art micro-GPS tracking devices in order to explore species movement patterns. Recently Joshua has made progress on a problem that has, with the exception of one special case, eluded researchers since the 1950s, namely providing a robust and efficient method of evaluating the distribution of the final size of an epidemic. His paper in the *Journal of Theoretical Biology* in 2015, provides the *best* algorithm available for evaluating this distribution, not only for the special case already considered, but for a wider class of models with phase-type infectious period distributions.

Joshua's many achievements include supervision to completion of a PhD student and two MPhil students, and a number of government consultancies. He is, clearly, an outstanding researcher and a worthy recipient of the J.H. Michell Medal.

Congratulations Joshua!

ANZIAM 2016

Harvi Sidhu*

The 52nd ANZIAM Conference was held from 7–11 February 2016 at the QT Canberra Hotel, Australia. The conference was well attended with a total of 202 delegates which resulted in a full programme of eight plenary presentations, and 168 contributed talks of which 76 were student presentations. The conference had numerous highlights including the eight invited talks, the Early Career Workshop, the Women in Mathematics Lunch, a special Mathematics Education Workshop for school teachers, a student event on the evening of Monday 8 February, a popular wine tour on the talk-free afternoon, and the Conference Dinner and Awards Ceremony. Furthermore, members of the organising committee ensured that all of the conference highlights were communicated via social media!

The eight plenary talks included presentations by the 2015 J.H. Michell and E.O. Tuck Medallists:

- Barry Cox (University of Adelaide — 2015 J.H. Michell Medallist): 'Various models for graphitic nanostructures';
- Edmund Crampin (University of Melbourne): 'Mathematical modelling of calcium signalling in heart cells: from ion channels to whole cell models';
- Jim Denier (Macquarie University): 'The delightfully complex dynamics of some unsteady fluid flows';
- John Dold (University of Manchester): 'A Selective History of Combustion Modelling';
- Troy Farrell (Queensland University of Technology — 2015 E.O. Tuck Medallist): 'Mathematical Modelling of Li-ion Battery Cathodes';
- Vivien Kirk (University of Auckland): 'Making good use of time';
- Petra Kuhnert (CSIRO, Adelaide): 'Assimilating modelled catchment loads with monitoring data to estimate sediment loads to the Great Barrier Reef: a Bayesian approach';
- Karen Willcox (Massachusetts Institute of Technology): 'Multifidelity Methods for Design and Uncertainty Quantification'.

Details of all talks, including short biographies of the invited speakers, are available on the conference website http://anziam2016.com/. The organising committee is grateful to members of the invited speakers committee for the above excellent selection of invited speakers: Peter Taylor (Chair); Boris Baeumer; Sanjeeva Balasuriya; Richard Clarke; Markus Hegland; James McCaw; Kerrie Mengersen; Mary Myerscough; Jason Sharples; Harvi Sidhu and Natalie Thamwattana.

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The Early Career Workshop was held at the QT Canberra Hotel on the afternoon of 6 February and the morning of 7 February, immediately before the main ANZIAM Conference. This is the second time that such a workshop has taken place during the period of the ANZIAM Conference, the first being at ANZIAM 2014. (This workshop alternates between the AustMS and ANZIAM Conferences.) There were 23 registered participants, which was a little disappointing considering there were no registration costs associated with the workshop. However, the feedback from participants was very positive. There were six invited speakers and panellists: Peter Taylor, University of Melbourne; Steve Barry, Airservices Australia; Jane Sexton, Geoscience Australia; Michael Plank, University of Canterbury; Adelle Coster, UNSW and Alexandra Hogan, ANU. The organising committee (Melanie Roberts, IBM; Roslyn Hickson, IBM; Leesa Sidhu, UNSW Canberra), together with the invited speakers formed a very lively panel during the Q&A sessions. The meeting finished off with lunch at the QT Hotel. The organisers would like to thank ANZIAM, AustMS and AMSI for their financial support for this important workshop.

On the Monday evening, around 40 of the student cohort gathered at PJ O'Reilly's pub for a social event organised by Rachael Quill and Alexandra Hogan. Students were able to meet and socialise in the less formal setting and chat over some finger food provided by ANZIAM. The students voted to put Laura Karantgis forward as the incoming Student Representative on the ANZIAM Executive, and it was also an opportunity to promote the Cherry Ripe Prize.

The Women in Mathematics Lunch was held on the Tuesday, with 58 participants (including 12 males). The lunch was chaired by Adelle Coster from the UNSW, and the panel consisted of Karen Willcox, Vivien Kirk and Petra Kuhnert. The panel discussion at the lunch was positive, focussing on the role of teaching and service in academic careers, academic leadership and encouraging young women to consider mathematical careers. The ANZIAM 2016 organisers thank ANZIAM, the Women in Mathematics Special Interest Group of the AustMS and the Australian Research Council through Professor Nalini Joshi's Georgina Sweet Australian Laureate Fellowship for supporting this event.

The inaugural Mathematics Education Workshop was run on the Tuesday afternoon, as a satellite event to this year's ANZIAM conference. The program consisted of two sessions of two hours, each with six speakers. The second session received Teacher Quality Institute accreditation for primary and secondary school teacher professional development. The event proved to be popular, with more than 100 people registering, including 50 mathematics teachers from ACT schools. The speakers covered a wide range of topics, from tips and techniques for improving mathematics education, to initiatives for increasing contact between tertiary and secondary mathematics teachers. The feedback from the school teachers was overwhelmingly positive, which is a testament to the importance of keeping in touch with the teacher community. Videos of all talks may be found at http://tinyurl.com/zr22uxe. The organisers would like to thank Associate Professor Chris Tisdell (Associate Dean, Faculty of Science, UNSW), and Professor Warrick Lawson (Head of School, School of Physical, Environmental and Mathematical Sciences, UNSW Canberra) for providing financial support.

Also on the talk-free afternoon, 20 delegates went on a wine tour to Mount Majura Vineyard, led by Alexandra Hogan. Mount Majura is well known in Canberra for its Tempranillo. The participants tasted 12 different red and white wines (all 'very nice!'), accompanied by local cheeses and regional delicacies. Following the tasting, they were given a tour of the grape pressing and wine-making facilities. A late afternoon stroll through the grapevines was topped off by spotting some kangaroos, who were kind enough to pose for a photograph.

The venue for the Conference Dinner and Awards Ceremony was the National Museum of Australia, located on the shores of the beautiful Lake Burley Griffin. The Museum's stunning architecture greeted the delegates after their short walk from the conference venue on the evening of Wednesday 10 February. During the course of the evening, delegates enjoyed their meal and drinks in a relaxed atmosphere. The main highlight of the evening was the announcement of several special ANZIAM awards. The following awards were announced:

- The 2016 ANZIAM Medal: Dr Frank de Hoog (CSIRO). The ANZIAM Medal is the premier award offered by ANZIAM. It is presented biennially. Full citations for the ANZIAM and Michell Medals appear in the preceding article.
- The 2016 J.H. Michell Medal: Associate Professor Joshua Ross (University of Adelaide). The J.H. Michell Medal is awarded annually by ANZIAM to at most one outstanding new researcher who has carried out distinguished research in applied and/or industrial mathematics within Australia and New Zealand.
- The 2016 A.F. Pillow Applied Mathematics Top-up Scholarship: Mr Alexander Tam (University of Adelaide). This award is for a PhD student in applied mathematics.

Left: Robert McKibbin congratulating Frank de Hoog for being awarded the ANZIAM Medal. Right: Yvonne Stokes with the recipient of the J.H. Michell Medal, Joshua Ross.

This year, the committee decided to break from tradition and announce both the T.M. Cherry Prize and the Cherry Ripe Prize after the last talk of the conference on Thursday afternoon as part of the closing ceremony of the conference.

The T.M. Cherry Prize is awarded for the best student talk at the ANZIAM conference. With 76 excellent student talks to judge, the T.M. Cherry committee

Mark Nelson congratulating the joint winners David Arnold (left), and Adrianne Jenner (right).

certainly had their hands full! Indeed, the standard of student talks was so high in 2016, that the committee were unable to distinguish between the top two students. Mark Nelson, the Chair of the T.M. Cherry Prize Committee, announced the winners:

- Mr David Arnold (University of Adelaide) for his talk 'Flow in spiral channels with arbitrary cross-section';
- Ms Adrianne Jenner (University of Sydney) for her talk 'Mathematical modelling of viral oncolysis: A PEG-modified adenovirus conjugated with herceptin'.

We are grateful to Mark and all of the members of his committee for their time and effort in judging all student talks.

On registration at ANZIAM 2016, students were informed of the Cherry Ripe Prize and were provided with voting slips. A few votes were submitted throughout the conference, with a surge on the last day once students had the opportunity to see as many non-student talks as possible. A meeting took place at morning tea on Thursday to allow students the opportunity to give more detailed feedback. The meeting was attended by approximately 15–20 students. A variety of speakers were nominated for the prize and given high praise by the students. Adelle Coster, Mark Nelson and Larry Forbes were given Honourable Mentions. The winners of the 2016 Cherry Ripe Prize were Melanie Roberts, who clearly showed her passion for her work, and Matthew Simpson, who 'nailed it'!

Social Media formed an important part of ANZIAM this year! A lively Twitter discussion took place throughout the week with hashtag #ANZIAM2016, reaching as far as the International Centre for Mathematical Sciences in Edinburgh, UK. A Facebook page was also used to advertise the conference and associated events, as well as to publish many of the photos taken by Mark McGuinness and a number of conference attendees.

The ANZIAM conferences are important fora for students to attend and present their research. However, this involvement is only possible when suitable funding is available for students. Hence we would particularly like to acknowledge the CSIRO Student Support Scheme which assisted 32 students to attend ANZIAM 2016.

We also would like to thank all our sponsors: UNSW Canberra; College of Science and Mathematical Sciences Institute, ANU; School of Physical, Environmental and Mathematical Sciences, UNSW Canberra; ABARES, Department of Agriculture; Canberra Convention Bureau Inc; PDE Solutions Inc; LEAP Australia Pty Ltd; TECHNIC Pty Ltd and Overleaf. The financial and in-kind support have certainly made a huge difference in our ability to organise ANZIAM 2016 and all associated activities successfully.

The organising committee looking relaxed after the conference on Thursday.

I personally wish to thank the conference organising committee: Tristram Alexander (UNSW Canberra); Rowena Ball (ANU); Alexandra Hogan (ANU); Zlatko Jovanoski (UNSW Canberra); Rachael Quill (UNSW Canberra); Jason Sharples (UNSW Canberra); Leesa Sidhu (UNSW Canberra); Isaac Towers (UNSW Canberra) and Edward Waters (The University of Notre Dame Australia) for all their hard work in making this a successful conference. I would also like to acknowledge the assistance of Matthew Simpson and Scott McCue who provided useful advice and feedback from ANZIAM 2015, and Julia Piantadosi for always being there to offer helpful suggestions and support. Finally, many thanks to Mark McGuinness for all his hard work to ensure that we have a great photographic record of ANZIAM 2016!

Mathematics contest problems: Please donate generously!

Norman Do*

About once every three years, the Senior Problems Committee of the Australian Mathematical Olympiad Committee (AMOC) turns to the mathematical community to donate contest problems. Previous appeals by my predecessor Hans Lausch attracted submissions that ended up on both national and international mathematical olympiads. Often, the inspiration for composing such problems strikes while reading research papers or while carrying out research. So I encourage you to be vigilant and to submit your problems — perhaps even just kernels of ideas for problems — to me via email. As always, due credit will be given to all problem donors.

Olympiad problems rely only on pre-calculus mathematics and are often broadly classified into the following four areas: algebra, combinatorics, geometry, and number theory. The role of the AMOC Senior Problems Committee is to write the papers for two national competitions and to submit problems for consideration at two international competitions. To give some idea of what we are looking for, we briefly describe these four competitions below and present an example problem from each. These have been submitted by members of the Australian mathematical community in the past three years. The hope is that many more of you will come forward with your problem creations over the coming years.

- **AMOC Senior Contest**

  Approximately 80 Australian students up to Year 11 sit this competition in August each year. The following geometry problem was composed by Angelo Di Pasquale and appeared as Problem 1 on the 2014 AMOC Senior Contest.

  > Each point in the plane is labelled with a real number. For each cyclic quadrilateral $ABCD$ in which the line segments AC and BD intersect, the sum of the labels at A and C equals the sum of the labels at B and D.
  >
  > Prove that all points in the plane are labelled with the same number.

- **Australian Mathematical Olympiad (AMO)**

  Approximately 100 Australian students up to Year 12 sit this competition in February each year. The following combinatorics problem was composed by Andrew Elvey Price and appeared as Problem 8 on the 2015 AMO.

  > Let n be a given integer greater than or equal to 3. Maryam draws n lines in the plane such that no two are parallel. For each equilateral triangle formed by three of the lines, Maryam receives three

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apples. For each non-equilateral isosceles triangle formed by three of the lines, she receives one apple.

What is the maximum number of apples that Maryam can obtain?

- **Asian Pacific Mathematics Olympiad (APMO)**

Approximately 30 Australians students up to Year 12 sit this competition in March each year. In 2015, the Australian contingent was placed ninth out of a total of 33 countries. The following number theory problem was composed by Angelo Di Pasquale and appeared as Problem 2 on the 2016 APMO.

A positive integer is called *fancy* if it can be expressed in the form

$$2^{a_1} + 2^{a_2} + \cdots + 2^{a_{100}},$$

where $a_1, a_2, \ldots, a_{100}$ are non-negative integers that are not necessarily distinct.

Find the smallest positive integer n such that no multiple of n is a fancy number.

- **International Mathematical Olympiad (IMO)**

Australia sends a team of six students up to Year 12 to take part in this international competition in July each year. In 2015, the Australian team were placed sixth out of a total of 104 countries. This was Australia's best performance since first competing at the IMO in 1981. The following algebra problem was composed by Ross Atkins and Ivan Guo and appeared as Problem 6 on the 2015 IMO.

The sequence $a_1, a_2, \ldots$ of integers satisfies the following conditions:

(i) $1 \leq a_j \leq 2015$ for all $j \geq 1$;

(ii) $k + a_k \neq \ell + a_\ell$ for all $1 \leq k < \ell$.

Prove that there exist two positive integers b and N such that

$$\left| \sum_{j=m+1}^{n} (a_j - b) \right| \leq 1007^2$$

for all integers m and n satisfying $n > m \geq N$.

Remarkably, this problem is inspired by juggling! The original idea for the problem came about while Ross Atkins was reading the paper 'Positroid Varieties: Juggling and Geometry' by Allen Knutson, Thomas Lam and David Speyer. (Thomas Lam was actually a member of the 1997 Australian IMO team and a recipient of an IMO gold medal.) Intuitively, each term a_i in the sequence corresponds to throwing a ball at the ith second with an air time of a_i. The inequality condition ensures that no two balls land simultaneously. The problem was considered to be very difficult, with a full solution for the problem obtained by only 11 of the 577 participants at the 2015 IMO.

Australia-Japan Geometry, Analysis and their Applications

University of Adelaide 19–23 October 2015

Melissa Tacy*

Global analysis relies on combining ideas from the complementary areas of geometry and analysis. This workshop brought 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.

Report

The Australia-Japan Geometry Analysis and their Applications workshop gathered a diverse group of mathematicians primarily from Australia and Japan in Adelaide to build research links in the area of geometry and analysis.

Geometry and analysis are highly complementary fields of inquiry. Geometrical information is vital to performing analysis on manifolds, such as studying the long-time solutions to evolution equations. These evolution equations can then be used to analyse the behaviour of solutions to related linear and non-linear PDE. On the other hand, techniques from analysis often prove useful in geometry. For example geometric considerations in gauge theory can be characterised by non-linear PDE.

The workshop kicked off with a pair of morning talks by eminent mathematicians — Mikio Furuta from the University of Tokyo and Peter Bouwknegt from the Australian National University. Furuta discussed inequalities in Topological Quantum Field Theory. Bouwknegt introduced the audience to the idea of T-duality as a geometric version of harmonic analysis.

The next four days were full days of talks that alternated between Japanese and Australian speakers, on topics ranging from geometry and topology, analysis and differential equations, operator algebras, and mathematical physics. All speakers made significant efforts to frame their talks in a way that could be understood by a wide range of mathematicians with backgrounds in geometry and analysis. This effort meant that participants of the workshop were able to appreciate the research and results from other areas.

Due to the diverse backgrounds of the participants an important part of this workshop was the open problem session that provided an informal forum for participants to get to know the areas represented. We began with a round of introductions, so that everyone got an idea of each other's backgrounds and interests. There were several short presentations on open problems, which the participants had

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encountered in their research. The hope was to get others interested in these unsolved problems, and to share some ideas for solving them. This turned out to be a very successful session with discussions on a problem presented by Guo Chuan Thiang leading to progress in his problem that has subsequently been published on arxiv (http://arxiv.org/abs/1510.04785).

Organising Committee

- Dr Melissa Tacy (University of Adelaide) (Chair)
- Dr David Baraglia (University of Adelaide)
- Professor Alan Carey (Australian National University)
- Professor Tsuyoshi Kato (Kyoto University)
- Dr Guo Chuan Thiang (University of Adelaide)
- Professor Mathai Varghese (University of Adelaide)

Organisers' opinion of success

Overall the organisers were very pleased with the success of this workshop. Given the wide range of backgrounds among the participants one of the primary challenges for this workshop was to ensure that ideas were communicated across these fields. That this was successfully achieved was in no small part due to the hard work put in by our speakers to make their talks accessible to wider audiences than a usual disciplinary conference. Their efforts were greatly appreciated. A number of participants commented, in the evaluation forms, on the quality of the talks. The open problem session was well attended and the attendees participated actively.

On the organisational side we were also very pleased with how the social program interacted with the mathematical one, in particular the icebreaker and the conference dinner. The icebreaker was held at lunch on the first day directly before the open problem session. This event achieved its objective which was to break down the barriers between participants, many of whom did not already know each other, before the open problem session. This led to the atmosphere at the open problem session being relaxed and informal which contributed in large part to its success. The workshop dinner was held at the Riverside Restaurant at InterContinental Adelaide, and was attended by Adelaide's Deputy Vice Chancellor (Research) who gave the after-dinner speech. In addition to celebrating the workshop and the links between Australian and Japanese mathematics, the dinner was also an occasion to celebrate the 70th birthday of Oxford mathematician and long-time Adelaide visitor Dr Keith Hannabuss.

Given the low number of women in the fields represented and in Australian mathematics in general we felt that we successfully attracted a representative number of women to the workshop. To improve the numbers of female participants at this and similar event would require significant improvement at a higher level of the number of women involved in mathematics in Australia.

Program

The program can still be found at http://www.iga.adelaide.edu.au/workshops/WorkshopOct2015/schedule.html

Analysis and Geometry in Non-Riemannian Spaces

Alessandro Ottazzi*

The School of Mathematics and Statistics of the University of New South Wales (UNSW) hosted the 'Workshop Analysis and Geometry in Non-Riemannian Spaces' in collaboration with the Australian Mathematical Society. The Workshop was held at the School of Mathematics and Statistics of UNSW from 2 to 4 November 2015.

Michael Cowling (UNSW) opened the inaugural session with a brief introduction. He explained the intentions and the purposes of the Workshop, which was organized to gather mathematicians working in the setting of non-Riemannian spaces both from the point of view of analysis and geometry, with the goal of promoting the synergy between these two areas of Pure Mathematics. The basic idea is that once one endows a Lie group (and more in general a homogeneous manifold) with a left-invariant length distance, it becomes possible to associate to such groups differential operators that are intrinsic in a similar way as the Laplace–Beltrami operator is for Riemannian manifolds. This observation links together differential geometry problems in Lie groups and homogeneous manifolds to harmonic analysis questions. It is a fact that a better understanding of the geometry of these spaces facilitates the comprehension of analytic problems.

The workshop lasted three days and was organized as follows: five one-hour lectures the first day, four the second day and three the last day. On the one hand, a relative small number of contributions allowed enough time to the speakers to present their work in some detail. On the other hand, the participants could take advantage of the breaks to discuss problems with the invited speakers and among each other. Here is a list of topics that were addressed: harmonic analysis on Lie groups and homogeneous spaces (sub-Laplacians, spectral analysis, Hardy spaces and BMO); CR-geometry and parabolic geometry (conformal structures, complex structures, holonomy); geometry of groups (Coxeter groups, metric geometry of nilpotent Lie groups).

Most of the lectures were given using Beamer presentation supplemented by the use of the whiteboard. The pdf files of the presentations will be available in the webpage of the event: http://conferences.science.unsw.edu.au/SR2015/index.html. Here is the list of the speakers (in alphabetical order): Xuan Duong (Macquarie University), Michael Eastwood (University of Adelaide), Tom ter Elst (University of Auckland), Rod Gover (University of Auckland), Enrico Le Donne (University

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of Jyväskylä), Thomas Leistner (University of Adelaide), Ji Li (Macquarie University), Gerd Schmalz (University of New England), Adam Sikora (Macquarie University), Stephan Tillmann (University of Sydney), Anne Thomas (University of Sydney), Lesley Ward (University of South Australia). The Workshop was attended by 20 people, some of them graduate students. There have been productive interactions, which in some cases led to new collaborations. While a small new network has been created and new projects between mathematicians in Australia and New Zealand are growing, the organizers look forward to a second meeting around similar topics next year!

J. P. O. (Phil) Silberstein

1920 – 2016

Josef Philipp Otto (Phil) Silberstein was Professor of Pure Mathematics at the University of Western Australia from 1966 until his retirement in 1985. He had been recruited to UWA in 1960 as Reader in Pure Mathematics, from his position as Principal Scientific Officer at the Aeronautical Research Laboratory in Melbourne. As an Emeritus Professor of UWA he maintained an active association with the University, especially through UWA music and the UWA Library. Phil died on Sunday 28th February after, in the words of his family, "95 years of sharing love, fun, laughter and knowledge".

Phil Silberstein was born in Vienna on July 5, 1920, just before the birth of his identical twin brother Peter. Their father Friedrich Silberstein was an experimental pathologist at the university in Vienna, and he had met their mother in Hamburg, where she was matron of a hospital. Unfortunately Phil's mother died in 1933 from cancer. Phil and Peter and their elder sister, Margarete, left Austria in 1938, first for England where they completed the London Matriculation in three months, and then, aged 18, they emigrated to Australia, arriving in Melbourne in February 1939.

Phil was first employed as a junior laboratory assistant in the Aeronautical Research Laboratories (ARL) within the newly formed Council for Scientific and Industrial Research (CSIR, a forerunner of CSIRO), and studied as an evening student for an Aeronautical Engineering Diploma at "Melbourne Tech", now RMIT. After completing the theoretical part of the diploma, Phil transferred to the University of Melbourne, again as a part-time student, and completed a BA with honours in Mathematics in 1944. By this stage the ARL was part of the

Department of Supply, and Phil had been working experimentally and theoretically on the "strength of wooden box spars, and the stability of flat and curved plywood panels". Later he worked on aircraft engine and propeller vibration with Professor E. R. (Russell) Love who had been seconded to the ARL from the University of Melbourne.

In 1947 Phil was awarded a three year CSIR Studentship to Cambridge University in the UK, where he worked under the supervision of functional analyst Frank Smithies on spectral properties of linear operators in Hilbert spaces. He completed his dissertation after returning to the ARL in Melbourne and was awarded a PhD from Cambridge in 1952. In 1954 he became Principal Scientific Officer at ARL, engaged in experimental and theoretical work in Applied Mathematics, mainly related to elasticity. By the time he was recruited to UWA five years later, he had written a large number of ARL Reports and published several mathematical articles. Phil had been attracted to UWA by Professors A. L. (Larry) Blakers and Harry Levey, and he, in turn, encouraged applied mathematicians John Mahony and David Hurley to come to UWA.

At UWA Phil Silberstein's interests moved from Applied Mathematics to Pure Mathematics since he believed that modern analytic techniques had a crucial part to play in developing new solution methods and their justification. He built up a strong team in mathematical analysis. Phil had broad interests across the university. He had a sustained involvement with the Convocation of UWA. He was a Foundation Member and former President of the Friends of the UWA Library. He was a long term supporter of the Friends of UWA Music.

Phil is survived by his wife of 62 years Judith, their sons Richard and Rodney and daughter Katharine, their grandchildren, and by Phil's twin brother Peter. Echoing the words of his family, Phil "was a real contributor to life and enjoyment of all around him. He loved mathematics, music and life in general. He will be sorely missed."

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Book Reviews

Mathematical Curiosities

Alfred S. Posamentier and Ingmar Lehmann
Prometheus Books, 2014, ISBN 978-1-616-14931-4

The authors are well known as mathematical expositors, and produce about a book a year. This is their 2014 offering, with the subtitle 'A Treasure Trove of Unexpected Entertainments'. It looked like just the sort of book I like: full of interesting tit-bits, discussions, exploration of some of the curious by-ways of mathematics, elementary topics outside the standard high school syllabus — a sort of grab-bag, if you like, of elementary mathematics. There's certainly a great deal in it, but sometimes I felt that there was almost *too* much, and that some topics merited greater depth than they received.

I'm not suggesting that a book for the general reader, or interested student, should have a high seriousness as if it were a research paper, and start with carefully presented definitions, to be followed with lemmas, theorems, corollaries, all with proofs, but I do think that any book of mathematics should endeavour to show some of the wonderful interconnectedness of mathematics, and provide just enough depth to make that possible.

However, it may be that Posamentier and Lehmann are attempting something different, and maybe they deliberately set out to include as many topics as they could. At any rate, I can't fault the book for lacking in breadth!

The contents

The book contains five chapters: Arithmetic Curiosities, Geometric Curiosities, Curious Problems with Curious Solutions, Mean Curiosities, An Unusual World of Fractions. In case some meaning was obscured by its trans-Pacific crossing, I looked up 'curiosity' in the American Heritage Dictionary, to find it means: 'An object that arouses interest, as by being novel or extraordinary', or maybe 'A strange or odd aspect'. I'm putting my money on the first meaning.

So we expect the book then to contain mathematical facts which are 'novel or extraordinary'. Many of them indeed are, but the limited space the authors allow for a topic means that sometimes one would wish for a bit more discussion. Take for example 'The Amazing Number 193,939' on page 40. The authors point out that this is prime, as are indeed five other permutations of its digits. In fact it turns out that there are 23 different permutations of the digits of 193939 which are prime, and the record number of prime permutations for six digit numbers is 123,479, which has 148. A few pages further on the authors discuss Ruth–Aaron numbers, which are consecutive numbers whose sum of prime factors is equal. The smallest such pair is 714 and 715, and they are named for the great baseball player

Babe Ruth, who hit 714 home runs in his career, and Hank Aaron, who beat Ruth's record nearly 40 years later. There are several pages filled with examples of Ruth–Aaron pairs (and triplets) but no discussion about how they can be found, or indeed if they can be generated in some way. The authors missed an opportunity to introduce a result [3] of Carl Pomerance and his students, which he described later [4] as being in a 'short, humorous paper', and which says that if

$$s = 2n + 1, \quad p = 8n + 5, \quad q = 48n^2 + 24n - 1, \quad r = 48n^2 + 30n - 1$$

are all prime, then $pq + 1 = 4sr$ and pq, $4sr$ is a Ruth–Aaron pair. (Incidentally, it was this short humorous paper which was the genesis of the long and fruitful collaboration between Pomerance and Paul Erdős.)

Examples of verbiage in this first chapter consist of the full integer representation of 2^{2^n} up to $n = 9$ (without, however, any mention of Fermat primes), and several pages given over to solutions to the 'four fours' problem: representing every integer from 1 to 100 using only four fours and arithmetic operations. From the slightly blurry look of these digits, I'd say that these were scanned in as an image from another source, which seems lazy.

There are also examples of what look like hasty editing, such as on page 102, when the authors discuss alternating factorial sums:

$$n! - (n-1)! + (n-2)! - \cdots - (-1)^n$$

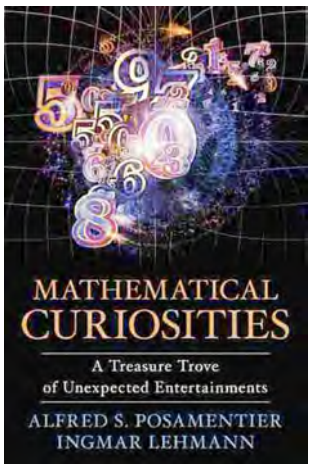
and give the sums for n from 3 to 8, and then say: 'These sums are always prime numbers.' In fact the next sum, with $n = 9$, is composite. What the authors meant to say, and indeed should have said was: 'These first six sums are prime numbers.' They seem to contradict their own assertion by pointing out that further sums are not necessarily prime, which is of course true.

Note that the sequence of integers for which the alternating factorials are (probably) prime is number 001271 in the Online Encyclopædia of Integer Sequences; this wonderful resource gets not a single mention in the book.

The chapter contains a discussion on what the authors refer to as "the most curious 'number' or quantitative concept ∞". The discussion is at times a little unclear, for example when referring to the symbol ∞ as a 'concept'. They say, quite correctly (if a little informally), that 'there are, in fact, orders of magnitude of infinity', but instead of leading into a discussion of Cantor's diagonal argument, they simply show that an infinite set can have a one-one correspondence with a proper subset. This is one place where more discussion is definitely needed: the various uses of infinity in mathematics can be extraordinarily confusing to the learner, and the space here is simply insufficient to clarify possible misunderstandings. I think it is a brave and wonderful thing to include a discussion of ∞; I would have liked to have seen a bit more.

I especially liked the geometry chapter, which contains several sections. One is on Japanese 'Sangaku' or Temple Geometry problems. These were geometric problems posed by anyone, and hung on wooden tablets inside temples during Japan's isolationist Edo period (1603–1868). These problems range from school geometry exercises to highly non-trivial theorems. Possibly the best known is now known

as the 'Japanese theorem', and states that for any cyclic polygon, the sums of inradii of the triangles in a triangulation is independent of the triangulation. The best account of these problems and their history is by Hidetoshi and Robinson [2]. Here the authors choose only those problems amenable to simple solutions; the solutions are not particularly elegant or unexpected, and contain the usual mixture of algebra and geometry. Some of the diagrams are overly complicated and messy, and there is a confusing mixture of font shapes and sizes. In at least one diagram (2.23) there are so many tiny labels crammed into so small a space that it's well nigh impossible to work out what's going on.



There is a section about 'squaring the square': that is, subdividing a square into smaller squares no two of which are equal. This is a fabulous problem, and seems to have first been solved by the eminent graph theorist William Tutte and three of his co-students as undergraduates in Cambridge in 1938 [1], although the first published squaring was in 1939 by the German mathematician Roland Sprague. None of these names are mentioned. Instead the authors erroneously claim that the first squaring was achieved in 1964 by J.C. Wilson. But there are some pretty pictures.

There is a nice section on quadrilaterals, which do indeed have a host of interesting elementary theorems. Cyclic quadrilaterals in particular are fascinating beasts. The authors do not distinguish between convex, non-convex, or self-intersecting quadrilaterals.

The third chapter, 'Curious problems with curious solutions' is not really either: these are 90 fairly standard elementary mathematical brain teasers, some of which admit to an 'aha!' solution; others which simply require some geometry, algebra, or arithmetic.

The fourth chapter on means, is certainly a fascinating topic, and less studied than it should be, but the standard inequality relating the arithmetic, geometric and harmonic means A, G and H is at least well known: $H \leq G \leq A$. The authors unfortunately adopt some very poor notation, writing

$$a \,\text{Ⓐ}\, b, \quad a \,\text{Ⓖ}\, b, \quad a \,\text{Ⓗ}\, b$$

for the arithmetic, geometric and harmonic mean respectively of a and b. The problem with this notation is that it makes these means look like operators, which clearly they are not: a Ⓐ b Ⓐ c is *not* the arithmetic mean of a, b and c. Moreover, it takes space and adds confusion. Much of the chapter is devoted to geometric proofs of the above inequality, taking in a few other means en route, such as the root mean square, the Heronian mean (which is $(a+\sqrt{ab}+b)/3$ in case you didn't know), the contraharmonic mean $(a^2+b^2)/(a+b)$ and the centroidal mean $2(a^2+ab+b^2)/(3(a+b))$, (which comes with its own typo as the *controidal mean*) without any discussion of their meaning, contexts, uses or history. Naturally each mean is introduced with the same operator-like notation we saw above. This

chapter actually contains some really good mixtures of geometry and algebra, I think let down a little by the notation and diagrams. The chapter finishes with the claim that mean inequalities 'is one of the neglected curiosities in mathematics worthy of our attention', which is unfortunately true, at least as far as elementary teaching goes.

The last chapter is mostly given over to discussing Leibniz' harmonic triangle, which consists of the fractions $1/n$ down each side, and for every triangular group

$$\begin{array}{ccc} & a & \\ b & & c \end{array}$$

then $a = b+c$. So every fraction is equal to the sum of the two fractions immediately below it:

$$\begin{array}{ccccccccccccccc}
 & & & & & & \frac{1}{1} & & & & & & & & \\
 & & & & & \frac{1}{2} & & \frac{1}{2} & & & & & & & \\
 & & & & \frac{1}{3} & & \frac{1}{6} & & \frac{1}{3} & & & & & & \\
 & & & \frac{1}{4} & & \frac{1}{12} & & \frac{1}{12} & & \frac{1}{4} & & & & & \\
 & & \frac{1}{5} & & \frac{1}{20} & & \frac{1}{30} & & \frac{1}{20} & & \frac{1}{5} & & & & \\
 & \frac{1}{6} & & \frac{1}{30} & & \frac{1}{60} & & \frac{1}{60} & & \frac{1}{30} & & \frac{1}{6} & & & \\
\frac{1}{7} & & \frac{1}{42} & & \frac{1}{105} & & \frac{1}{140} & & \frac{1}{105} & & \frac{1}{42} & & \frac{1}{7} & & \\
\frac{1}{8} & & \frac{1}{56} & & \frac{1}{168} & & \frac{1}{280} & & \frac{1}{280} & & \frac{1}{168} & & \frac{1}{56} & & \frac{1}{8}
\end{array}$$

The authors miss an opportunity of showing that every element in the triangle must be a unit fraction (which is not obvious from the definition), although they do show that the elements in the 'second oblique' are the fractions

$$\frac{1}{n(n+1)}.$$

Having discussed triangles, they can't resist a look at Pascal's triangle, but miss out on the basic relationship between the two triangles: if Leibniz' triangle is indexed from 1, then

$$L(m,n) = \frac{1}{m\binom{m-1}{n-1}}$$

Thus the denominators in Leibniz' triangle can be obtained by multiplying the nth row in Pascal's triangle by $n+1$. This is hinted at, but not stated as a general result.

This chapter, and the book, finishes with a discussion of the mediant of two fractions, defined as

$$\frac{a}{b} \oplus \frac{c}{d} = \frac{a+c}{b+d}.$$

The authors show that if all values are positive, then

$$\frac{a}{b} < \frac{a+c}{b+d} < \frac{c}{d}$$

and provide a few proofs, including a nice geometric one. Then they segue into Farey sequences and Ford circles.

Conclusion

I think that this book contains plenty of absolutely terrific stuff, unfortunately let down by lack of explanations, some poor choices of notation, and some unclear diagrams. That being said, there are also many places where the explanation (including the diagrams) is appropriate for the material. There are so many ways in which material from different parts of the book could be interrelated — and in my own experience as a teacher, showing that two apparently dissimilar topics are in fact deeply related provides a tremendous interest to students — but unfortunately there are none in this book.

The authors' love of mathematics, and appreciation for its breadth and history shines through on every page — for me this was one of its most attractive aspects.

The book could be considered, as I said in my introduction, as a sort of 'grab-bag' of elementary mathematics; any student would almost certainly find something to spark her or his interest in the book, and then could follow it up with greater depth either with the bibliographies at the end of each chapter, or online.

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[1] Gardner, M. (1961). Squaring the square. In *The Second Scientific American Book of Mathematical Puzzles & Diversions: A New Selection*. Simon and Schuster, New York, pp. 186–209

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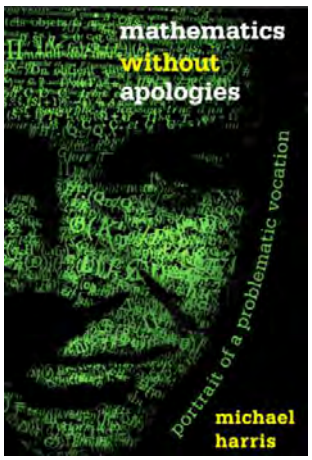
Mathematics Without Apologies

Michael Harris
Princeton University Press, 2015, ISBN 978-0-691-15423-7

This book was not the book I expected. It was at turns frustrating and cause for reflection on our field. While Harris openly says that this is not a scholarly work, and intended for the interested bystander, it is no *Fermat's Last Theorem* [3]. The

24-page bibliography and 68 pages of endnotes[1] lend an air of serious study. Others I know have merely sampled from the book, picking out the main points; perhaps this is sufficient until one wants to spend the effort to plough through the constant references to continental philosophers and literary theorists. This book reads like a work in sociology, but with a familiarity with mathematics, mathematicians and the current state of play one would be surprised to find in a sociologist.



That said, this book has grown on me since I put it down; it made me go back and read Hardy's *Apology* [1], for the sake of comparison, and I think there are some points from Hardy that are little referenced, and which are pertinent to our time, and Harris's update. Many know of the famous parts from Hardy: the passages about Ramanujan (for instance the 1729 story), the references to the young man's (sic) game, the exultation in the uselessness of number theory (now undone by modern cryptography) and so on. Hardy attempts to answer the question 'why do mathematics?', and then immediately confesses that, while posing several general potential answers, he is answering the question 'why did *I* do mathematics?'.

Hardy does, however, make a general point that we can no longer take for granted, and to which one can view Harris's book as an extended riposte:

> I may be told that mathematics needs [no apology], since there are now few studies more generally recognized, for good reasons or bad, as profitable and praiseworthy...The public does not need to be convinced that there is something in mathematics.

This viewpoint is, at least in the Anglosphere, terribly quaint, and almost laughable now; declining numbers of students taking mathematics tell us what 'the public' think of our field. Hardy then goes on to say how poetry is more valuable than cricket, to highlight why Bradman should play cricket rather than write poetry: it is the former that he does really well. The explicit implication is that mathematicians should stick to what they can do well, despite its comparative worth to other endeavours. Mathematics today is seen more as the poetry than the cricket by some. By way of illustration, Hardy mentions finance and the legal profession as occupations people might do because they lack facility in other areas. Harris, unintentionally, mirrors this, with discussion of mathematics and mathematicians' role in the financial crisis of the past decade.

So what is Harris's non-apology, as given away by the title? Namely this: that we do mathematics because we like to, that it has a sort of freedom of play, and,

[1] This reviewer bravely tried to read all the endnotes in context, but cannot claim to have done so successfully.

more implicitly, because it brings a form of prestige, for which he uses the term 'charisma'. This charisma is evident in people such as Cedric Villani, the Fields medallist who has shot to national fame in France, but also, justly, holds high position in mathematical circles; Robert Langlands, who as Edward Frenkel likes to emphasise, has Einstein's old office in Princeton; and our own Cheryl Praeger, recognised for her research but also trailblazing for women mathematicians in Australia.

Harris illustrates the, or at least *a*, path to charisma by telling what seems like his own story, but which he has since on his blog [2] declaimed as being fictionalised.[2] The 'Michael Harris' in the book is not Michael Harris the author, or so he says. At the very least, the path of finding oneself integrated into the Langlands programme and proving significant parts of it, is not one that most mathematicians can identify with. Finding oneself fêted and published by the 'great journals' is a distant dream for those that make up the rank and file of mathematicians.

The 'relaxed field' that Harris discusses — while perhaps true while we are in the business of proving theorems, playing with our mathematics, doing that which identifies us as mathematicians — is perhaps not the same for us as for those with charisma. The demands of day-to-day work, the administration, the teaching, the grant or job applications and so on, are not what one thinks of when reading the Cantor quote 'The essence of mathematics is in its freedom'. But we can perhaps see a lesser shadow of it, and certainly for this reviewer it played a big rôle in the decision to do mathematics long-term. Harris, however, doesn't shirk examining the everyday activities mentioned above. He makes a careful study of what *being* a mathematician is like. Reading this is a bit like discovering one has been speaking prose. Being written for those outside the system of mathematicians (and journals, and grants, and ...) it is an in-depth look at what we do, and generally how it works. The Gowerses, Taos and Villanis of the world, and presumably the Harrises (fictional or otherwise), still have *some* admin to do, still need to pass the editors, the gatekeepers of our literature, and so this section rings very true.

To give a bit more of an idea of what mathematicians do in terms of mathematics, in particular what he himself does, Harris indulges in a fictionalised account of an extended discussion between an anonymous Number Theorist and a Performing Artist, scattered in several chapters labelled by Greek letters. Each of these dialogues is preceded by what one might recognise as conventional 'popular mathematics book' material, to get readers up to speed. One can read the Greek-lettered chapters on their own as short, an almost independent book; likewise with the complement of the book. But the mathematics is not restrained to these chapters. Liberal discussion of contemporary mathematics in a more impressionist style is scattered throughout. In fact, I was pleasantly suprised to find Harris at home in

[2]Harris's blog, with the same name as the book, is a must for readers of the book. One can find reviews by others, together with takedowns by Harris of those he feels miss the point. Apparently it is common for reviewers to not get the point of the book, a fact to which this reviewer can only gesture mutely; he fully expects to join their ranks. But the existence of the blog allows Harris to explain himself more fully outside the constraints of the linear narrative of the book, and to further illustrate his points with current events, or sources not available at the time.

the digital humanities: he cites blogs (e.g. Terry Tao's *What's New*, the *n-Category Café*, *mathbabe*), MathOverflow, YouTube videos, Wikipedia articles, databases of rap lyrics and so on. Given the amount of mathematics that happens online today, and mathematics that is recorded online that would have been otherwise lost (for instance, Vladimir Voevodsky's contentious talk *What if current foundations of mathematics are inconsistent?*, given at the Institute for Advanced Study) it is only appropriate to include that in a study of what we do and why.

Which brings us back, finally, to what is Harris's main point: we do mathematics because we like to. Very few could honestly claim to do mathematics, or at least *pure* mathematics, entirely out of altruism to better humanity, or because of potential technological payoffs that may take a century to eventuate (the 'golden goose' argument, as Harris puts it). In this one sees why the book is titled *Without Apologies*. Hardy makes a similar point: 'Any genuine mathematician must feel it is not on these crude achievements that the real case for mathematics rests', where by 'crude achievements' he means practical applications such as 'bridges and steam engines and dynamos'. Villani seems to be fond of quoting, in talks and interviews, his countryman Weil on the pleasure of doing having mathematical ideas, which can last for 'hours at a time, even for days', and one wonders whether this is the ultimate reason for many for pursuing mathematics. It is worth contrasting Villani's recent book [4] with Harris's. It takes the approach of *showing*, rather than *telling* (like Harris), what mathematicians do, and his own enjoyment of it. The inclusion of emails between Villani and his collaborator quoted verbatim, complete with pseudo-LaTeX equations, is perhaps off-putting to the general reader (mathematicians may very much love it!), but then so might Harris's continental philosophy and sociology, his deconstruction of Pynchon novels in mathematical themes.

All in all, Harris's book is something people interested in the whys and wherefores of doing mathematics and being a mathematician should read. If one has curious friends or relatives of a literary bent, or versed in some form of humanities, then this may be the book for them. Despite being listed as general interest, some facility with (or willingness to look up) literature and philosophy spanning several languages is recommended.

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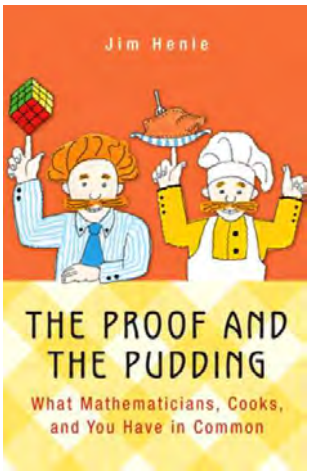
The Proof and the Pudding: What Mathematicians, Cooks and You Have in Common

Jim Henle
Princeton University Press, 2015, ISBN 978-1-400-86568-0

The Proof and the Pudding is not a book about mathematics *for* cooking.[1] On the back jacket of this book, a reviewer has been quoted as saying '[Henle] challenges mathematicians to be chefs and chefs to be mathematicians'. To me, this is not at all the message of the book.

The author compares the ways of thinking and acting that are common between his twin loves, mathematics and gastronomy. I'm not sure where bookshops put this book. The publishing data gives it a classification among mathematics books (Dewey Decimal 510), though it could equally well be found on the 640 shelves (home economics); my own preference would be to house it with motivational or study skills.



The practical and material aspects of gastronomy and mathematics are discussed and dismissed in less than a page (on page 110!). The author has a loftier purpose. This book is actually — if you read between the recipes and the maths puzzles and the excellent diagrams that illustrate them — about the need to be at times humble and self-doubting and at other times arrogant or confident, to experiment and learn by trial and error, to refine one's skills and products, to seek what is aesthetically pleasing, to be economic of effort, to persist, and to find enjoyment in one's labours as well as the fruit of them. Henle has distilled these ideas from his own experiences of cooking for his family and friends, and of mathematical collaboration and research. It is funny in many places, and inspiring. If you have ever served up a failed mousse or thrown away a couple of days' calculations, the stories in this book will resonate.

This is a personal reflection, written in an informal and individual tone, and you might not enjoy the style as much as I did. You may find some of the parallels a little forced and you might not like the sound of Shamburgers or blue pizza. You may not agree that mathematics has so much in common with all other fields of human endeavour (if that implies it is not quite so special). But you will find some cute little proofs and problems to illustrate your lectures, some Nim-like games to play and a very sophisticated card-trick. When we (or our students, perhaps our

[1] However, I did find a very useful fact (for non-Americans) on page 58: $1\frac{1}{3}$ sticks of butter $= \frac{2}{3}$ cups. I have often pondered this question. It seems you can't just pick your own stick.

graduate students) aren't as successful or creative in our mathematics as we are in our cooking/carpentry/figure-skating/gardening/photography/[insert your own hobby here], Henle reminds us

> It's just a question of desire. The same attitudes, the same mental approaches, the same problem-solving skills propel you forward. (p. 149)

Now, if I can work out how many punnets of blueberries make up a pint, I might be able to try the three-ingredient pudding recipe.

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Introduction to Nonsmooth Optimization: Theory, Practice and Software

Adil Bagirov, Napsu Karmitsa, Marko M. Mäkelä
Springer, 2014, ISBN 978-3-319-08113-7

This book is a welcome and much needed contribution to the field of Nonsmooth Optimization. In this self-contained text, the reader will find (i) the main theoretical tools for studying convex and nonconvex problems, (ii) concrete examples in which these tools are used, and (iii) a comprehensive guide to the available software to implement the solution techniques.

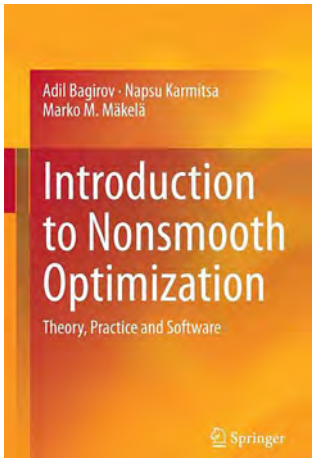
A nonsmooth optimization problem consists of minimising a function which may not be differentiable (in the classical sense) at the solution. This situation is relevant because it provides a more realistic representation of a wide variety of problems. Moreover, several new tools and techniques have recently been developed for these problems, and practitioners would greatly benefit from understanding when and how they can be implemented. This book addresses this need in a superb way. It is self-contained, it is very easy to read, and all the material has been arranged in three very well-organized parts.

Namely, in a single text, the reader has access to the three different and supplementary aspects of nonsmooth optimization listed above in (i)–(iii). Covering these three aspects in a comprehensive way is, as far as I know, a distinctive characteristic that makes this book unique among the currently available texts, and particularly appealing to both theorists and practitioners.

Readers are only required to have some basic background in linear algebra, multidimensional calculus and elementary real analysis. At the end of almost every chapter exercises are given and the contents are summarised. As a result, parts of this book can be used as a text for advanced (or masters/honours) students in

mathematics or engineering degrees. Rigorous mathematical proofs are given for most of the statements.

Part I collects the relevant theoretical tools on which nonsmooth optimization relies. Chapter 1 includes facts and definitions about locally Lipschitz functions. This type of function is to have a key role in subsequent chapters. Chapter 2 is devoted to convex analysis. The first part of the chapter has a geometric approach, focusing on projections, separation properties and convex cones. Theoretical properties of convex functions and their subdifferentials are studied in detail, and many illustrations and examples are presented. The epsilon-subdifferential and its connections with the classical subdifferential are clearly presented and motivated by their use in nonsmooth optimization methods. It is captivating to see in Section 2.3 how all the analytical tools are connected with geometrical objects, giving the reader the intuition to understand and enjoy better the theory.



Chapter 3 in Part I is devoted to nonconvex analysis, and it is here that the convex theory is extended to functions which are locally Lipschitz continuous. Since the latter may not be differentiable in the classical sense, the authors start by recalling the Clarke subdifferential and the generalized directional derivatives of locally Lipschitz functions, which will play the role of the derivatives for this more general family of functions. This is followed by the calculus rules that apply to these objects. Several illustrative examples are given to show the subtleties and the different aspects of the definitions, especially to point out that nonsmoothness can exist even for functions that are everywhere differentiable (Example 3.1). The role of the epsilon subdifferential in the convex case is now played by the Goldstein epsilon-subdifferential. The Jacobian of a vector-valued function is extended to locally Lipschitz continuous functions and subdifferential calculus is given in great detail. This includes the extensions of the chain rule, the mean value theorem, etc., to these concepts, accompanied by numerical examples. The geometrical aspects of nonsmooth problems, and their analogies with the convex case, are presented through the (Clarke) tangent and normal cones in Section 3.3. Other kinds of subdifferentials are recalled in Section 3.4, where the reader can also find the relationships between these concepts and the Clarke subdifferential. Chapter 4 presents the optimality conditions for nonsmooth optimization, both for the unconstrained and the constrained case. Very clear proofs, geometrical results, and illustrative examples give further motivations and captivate the attention of the reader. Special attention is given to the classical model using inequality constraints. Results which are analogous to Fritz John and Karush Kuhn Tucker conditions are presented and illustrated for locally Lipschitz functions in Section 4.3.

Chapter 5 considers problems that enjoy additional structure, and explains how this additional structure can be exploited. The functions of the problem are assumed here to be pseudo- or quasi-convex, which are two important cases in which

the convexity assumption is relaxed. The authors show how these assumptions can be used to derive optimality conditions. The main tool for deriving the results are the Clarke subdifferential and the generalized directional derivatives. Relaxed optimality conditions are given for the unconstrained and constrained problems, as well as for the model using inequality constraints. In all cases, the functions involved are either pseudo- or quasi-convex. In particular, Karush Kuhn Tucker conditions are recovered for the model with inequality constraints, in which the objective function is pseudo convex and the constraints are quasi-convex.

Chapter 6 focuses on approximating subdifferentials by means of continuous set-valued functions. In this context, it studies a concrete approximation of the subdifferential, called discrete gradient (introduced in 1999 by Adil Bagirov). The advantage of the discrete gradient is that it allows you to compute search directions by using only functional values. The concept of continuous approximation allows you to obtain in Theorem 6.8 an optimality condition in terms of discrete gradients. Section 6.3 considers piecewise partially separable problems, and shows how to compute the discrete gradients for these functions. These topics link with Chapter 15 in Part III, where it is shown (through two different methods) how the discrete gradients can be implemented. At the end of Part I, comprehensive historical references are given for all the concepts given in Chapters 1–6.

Part II of the book considers practical formulations of nonsmooth optimization problems of the form

$$\begin{array}{ll} \text{minimize} & f(x) \\ \text{subject to} & x \in S, \end{array}$$

where $f\colon \mathbb{R}^n \to \mathbb{R}$ is only assumed to be locally Lipschitz continuous over the set S. The authors classify the source of nonsmoothness as: physical, technological, methodological, and numerical. This part of the book focuses on all aspects of nonsmooth problems, going from the theoretical formulation of a comprehensive list of problems in Chapter 7, to a systematic list of nonsmooth test problems of various types in Chapter 9.

Chapter 7 describes in detail several important real-life nonsmooth problems, arising from computational chemistry and biology, data mining, optimal control, image denoising, and economics. All these models are explained in detail, which is very useful for mathematicians wanting to look into interdisciplinary applications. Of particular interest is Section 7.2 on Data Analysis, which presents a generalization of classical convex separation to the so-called polyhedral separation, whereby disjoint nonconvex sets are separated using piecewise linear functions.

We mentioned above that the authors classify nonsmoothness in four distinctive classes, and one of them is methodological nonsmoothness. Typical examples of this type of problems are Lagrangian relaxation, dual reformulation, and exact penalty functions. In these cases, a possibly smooth problem is reformulated as a nonsmooth one, where the loss in terms of differentiability is compensated by a gain in structure (and hence resulting in a methodological gain). This is the focus of Chapter 8, which describes the exact penalty formulation, integer programming with Lagrange relaxation, and the maximum eigenvalue problem.

The last chapter of Part II, Chapter 9, consists of an extensive and carefully classified list of test problems for nonsmooth optimization. All problems in this chapter are openly available and have been used to test, develop or compare nonsmooth software. Problems of most sizes and types can be found in this list, so this chapter will be an essential reference for those who want to understand, and/or compare the behaviour of methods for nonsmooth optimization. All the references to the problems and the historical notes are given at the end of this Part II.

Part III describes the main solution techniques used for solving nonsmooth problems. Subgradient-, cutting plane-, bundle-, and gradient sampling methods are discussed in Chapters 10–13. In Chapter 14 some combinations of the previous techniques are presented, including variable metric bundle, and limited memory bundle methods. The discrete gradient and some of its variants are presented in detail in Chapter 15.

Each technique given in Chapters 10–15 is explained theoretically, and the available convergence results are given. Moreover, pseudo-codes are given for all the methods.

All methods in Chapters 10–15 refer to the unconstrained problem. Chapter 16, however, explains two ways in which constraints can be incorporated into the objective, in such a way that the problem becomes unconstrained. The first one recalls the exact penalty approach given in Chapter 8, and gives a pseudocode for implementing it. The second one is the linearisation approach. The description of the latter approach is given for the convex case.

Finally, Chapter 17 compares different implementations of nonsmooth optimization methods. The comparisons here use a very large number of test problems, and the methods considered in Chapters 10, 12, 14 and 15 are included in the tests. Chapter 17 is designed to give insight into which method should be used for a given problem. A comprehensive list and description of available nonsmooth solvers and the corresponding references are given in Section 17.1. In Section 17.2, these methods are tested and compared using representative subsets of the test problems given in Chapter 9. These comparisons are made for problems of different sizes and types (convex and nonconvex). Convergence rates and the iteration paths are experimentally studied as well.

In summary, this book is an extremely valuable reference that collects and relates all the different facets of nonsmooth optimization, in a way that is comprehensive, captivating, and easy to follow.

Regina Burachik
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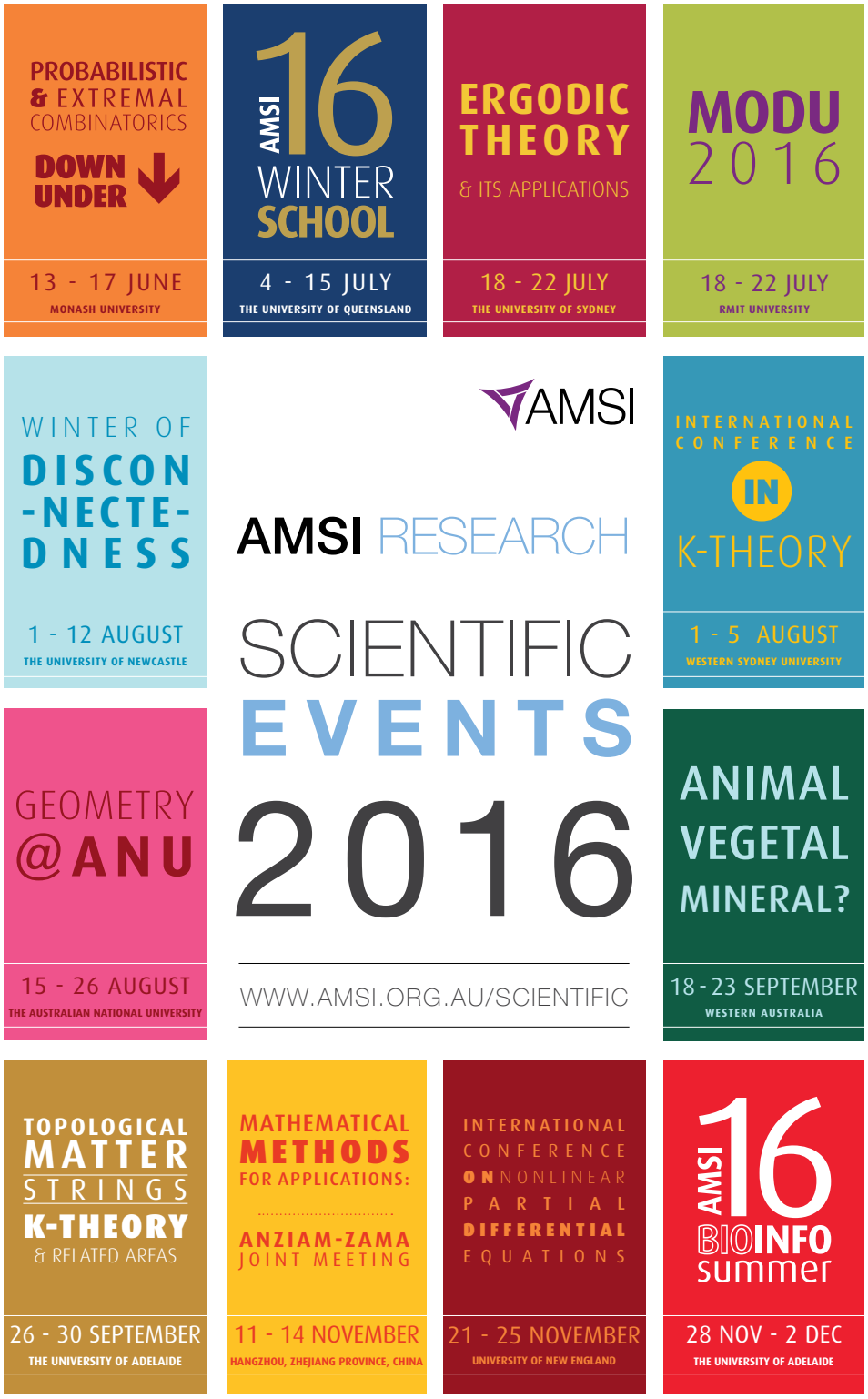
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AMSI 16 WINTER SCHOOL
4 - 15 JULY
THE UNIVERSITY OF QUEENSLAND
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& ITS APPLICATIONS
18 - 22 JULY
THE UNIVERSITY OF SYDNEY
MODU 2016
18 - 22 JULY
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WINTER OF DISCON-NECTE-DNESS
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ANIMAL VEGETAL MINERAL?
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26 - 30 SEPTEMBER
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ANZIAM-ZAMA JOINT MEETING
11 - 14 NOVEMBER
HANGZHOU, ZHEJIANG PROVINCE, CHINA
INTERNATIONAL CONFERENCE ON NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS
21 - 25 NOVEMBER
UNIVERSITY OF NEW ENGLAND
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28 NOV - 2 DEC
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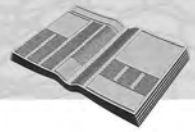
AMSI RESEARCH



NCMS News

Peter Forrester*

I have taken over the role as Chair of the National Committee for the Mathematical Sciences as of April this year. The outgoing Chair Professor Nalini Joshi has been responsible for a number of transformational initiatives, as brought about by her tireless advocacy for the role of the Mathematical Sciences in securing Australia's future, and her active addressing of the under-representation of women in our discipline. It's great to see that her efforts have been recognised by being a recipient of the 2015 Australian Financial Review and Westpac 100 Women of Influence Award, begin named as one of the inaugural Knowledge Society and the Office of the Chief Scientist 'Knowledge Nation 100' ('STEM heroes" category), her appearance on Q&A, her recent address to the National Press Club, amongst other public honours.

Nalini initiated the Australian Academy of Science Decadal Plan, by raising funds to support the process, formulating a structure to proceed and remaining throughout as one of the three members of the Decadal Plan Steering Committee, chaired by the late Professor Peter Hall, another champion of Australian Mathematical Sciences. The decadal plan was launched at Parliament House on 17 March. Ironically, due to a family bereavement Nalini was not able to attend, and her role for the occasion was replaced by Professor Cheryl Praeger. Also present at the launch was Peter Hall's widow Jeannie.

There's no doubt that there was a lot of good will shown by the high ranking politicians present at the launch: Education Minister Birmingham and assistant Science Minister Andrews. In particular, one of the three key priorities listed in the report, that there be a staged reintroduction of at least Year 12 intermediate level mathematics as a prerequisite for all bachelors programs in science, engineering and commerce, seemed to be well aligned with present government policy, as was point 1 from a vision for 2025: 'The mathematical sciences are critically important for Australia's future, especially in light of ongoing technological change'. The latter of these was a point consistently made by Professor Ian Chubb, in his role as Chief Scientist.

The report asks the National Committee for the Mathematical Sciences to formally monitor the progress on the plan. Professor Geoff Prince of AMSI, one the Decadal Plan Steering Committee members, has already taken initiatives on implementa-

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Email: p.forrester@ms.unimelb.edu.au

tion by arranging for a number of senior people to participate in a meeting with Ian Chubb, both to formally thank him for his efforts in advancing the causes of the Mathematical Sciences during his tenure as Chief Scientist, and furthermore to seek his council relating to strategies to work with government.

Peter Forrester received his Doctorate from the Australian National University in 1985, and held a postdoctoral position at Stony Brook before joining La Trobe University as a lecturer in 1987. In 1994 he was awarded a senior research fellowship by the ARC, which he took up at The University of Melbourne. Peter's research interests are broadly in the area of mathematical physics, and more particularly in random matrix theory and related topics in statistical mechanics. This research and its applications motivated the writing of a large monograph *Log-gases and Random Matrices* (PUP, Princeton) which took place over a fifteen-year period. His research has been recognised by the award of the Medal of the Australian Mathematical Society in 1993, and election to the Australian Academy of Science in 2004, in addition to several ARC personal fellowships. He was AustMS President from 2012 to 2014.

AMSI News

Geoff Prince*

On 14 April the Minister for Education and Training, Simon Birmingham, announced $2m in co-funding over four years for AMSI's research training programs.

This renewal of the 2012–2016 grant is a testament to our success for which I acknowledge all the hard work of AMSI members in hosting events, teaching courses and supervising students.

Simi Henderson, AMSI's program manager for research and higher education, also deserves our warm thanks and congratulations.

We are reproducing the Executive Summary of our renewal application in the interests of *Gazette* readers so that you can see what AMSI has planned for the period 2016–2020.

Executive Summary

The Project—'Securing Australia's Mathematical Workforce'

- An estimated 75% of jobs in the fastest growing industries requiring STEM-skilled workers, ensuring students have the skills to equip them for the workforce of the 21st century is critical to maximising Australia's productivity, and ensuring economic and social wellbeing in an increasingly STEM-based and digital economy.
- While Australia's research ranks highly in the OECD on indicators of quality, we rank last for business collaboration with researchers.
- Women occupy fewer than one in five senior researcher positions in Australian universities and research institutes, and around a quarter of the STEM workforce overall.

National Innovation and Science Agenda (Dec 2015)

Australia's innovation agenda cannot be delivered without a growing workforce of talented, mathematically capable professionals.

The Australian Mathematical Sciences Institute (AMSI) has achieved remarkable results in delivering its 'Vacation Schools and Scholarships' program with Australian government support in the years 2012–2016: sixteen national events and 1559 participants in total. As the national collaborative venture in the mathematical sciences AMSI is uniquely placed to continue to train and secure Australia's expanding mathematical sciences workforce.

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

AMSI proposes to deliver an extensive program of research training schools and scholarships, industry-research symposia in bioinformatics and optimisation, and PhD industry internships over the period 2016–2020. This education program will grow the nation's future public and private sector workforce with advanced skills in mathematical sciences and provide opportunities for increasing participation by female and indigenous students. Direct engagement with Australian companies and public agencies will be a strong and effective feature of the program, contributing to collaborations with the research sector.

The *Securing Australia's Mathematical Workforce* proposal aligns strategically and operationally with AMSI's $22m Choose Maths project, funded by the BHP Billiton Foundation, which will increase participation in school mathematics through the promotion of mathematically based careers. Our proposal provides a vital pull factor with a suite of exciting tertiary study and career pathways for this new generation of mathematically aware school students inspired by the Choose Maths program.

The Australian Mathematical Sciences Institute invites the Department of Education and Training to enter into a cost sharing agreement from 2016 to 2020 to deliver this innovative and strategic project.

Project objectives

The overarching objective is to contribute to the preparation of a world class mathematical sciences workforce. The specific project objectives are to:

A. strengthen research training and the work-readiness of advanced mathematical sciences graduates;

B. promote university-industry collaborations that will encourage the private sector employment of mathematical sciences graduates;

C. attract and improve the retention of senior undergraduate students in the mathematical sciences, with particular attention to women and Aboriginal and Torres Strait Islanders.

Project justification

Australia has experienced a radical change in science policy. Building STEM into our future has been identified as critical in sustaining innovation and productivity. The mathematical sciences form the foundation for advances in science, technology and engineering along with its own direct and major contribution to the nation's economy. However, the evidence unequivocally indicates that significant measures are needed to secure workforce supply in mathematics and statistics.

The proposed AMSI program aligns closely with a considerable part of the *National Innovation and Science Agenda* released by the Prime Minister and the Minster for Industry, Science and Innovation in December 2015. In particular, all the policies outlined under the 'Talent and Skills' heading and many of those under the 'Collaboration' heading are directly served by this proposal from AMSI.

Project implementation

AMSI will evolve and expand its successful Vacation Schools and Scholarships Project 2012-2016, co-funded by the Australian Government, to increase national STEM capacity through:

- embedded internships that integrate research training and commercial R&D and build innovation and entrepreneurial skills in students (project objectives A,B) ;
- industry-research training symposia in bioinformatics and optimisation (project objectives A,B);
- the delivery of the AMSI Summer and Winter Schools and Vacation Research Scholarships (project objectives A,B,C);
- industry focussed summer school subjects aligned to priority areas (project objectives A,B)
- dedicated financial support to increase female and indigenous participation in the mathematical sciences (project objective C).

As a key part of this evolution, we will undertake joint business development of industry-based PhD research internship program, AMSI Intern, and our industry facing events, BioInfoSummer and AMSI Optimise. In this way we will grow commercial engagement through increased business development capacity rather than direct financial subsidy to industry.

Project outcomes

Over the period 2016–2020 AMSI will deliver four Summer Schools, four Winter Schools, four editions of BioInfoSummer and three of AMSI Optimise. We will place more than 200 undergraduate students into research scholarships each summer and 45 PhD students into research internships with Australian companies. Our overall target is 1650 participants over the four years.

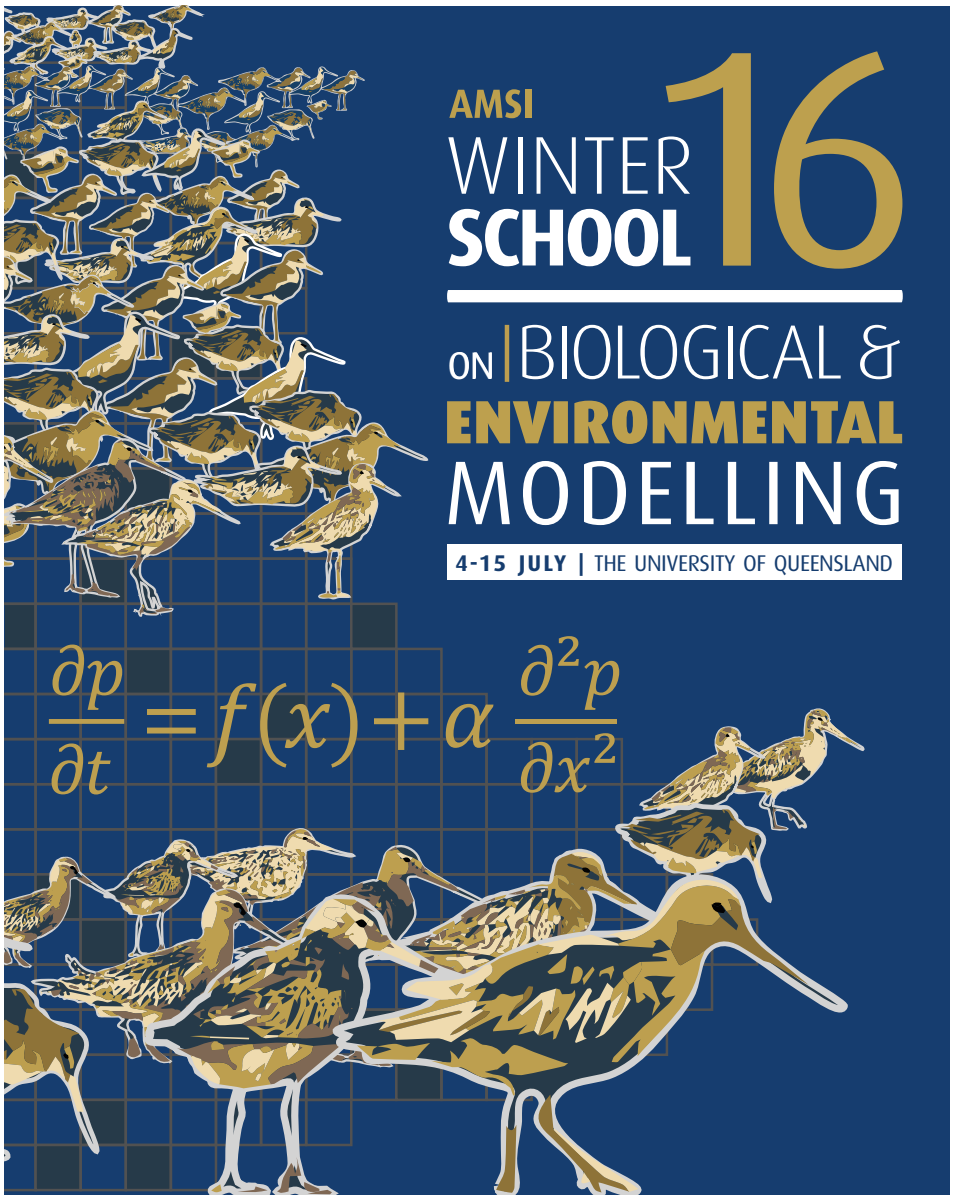
Some key measures of success in the period 2016–2020 are:

- increased graduations in the key areas of bioinformatics, optimisation and statistics/data science to meet heightened employer demand (project objectives A, B, C);
- successful delivery of AMSI industry and flagship events (project objectives A, C) measured by attendance and feedback from the participants;
- increased numbers of PhD students undertaking industry-based internships (project objectives A, B);
- increased university-industry collaborations commenced through internships (project objective B);
- increasing engagement of businesses in AMSI industry-research symposia (project objectives A, B);
- increased engagement of women and Indigenous students in AMSI research training programs (project objectives A, C).

Conclusion

The *Securing Australia's Mathematical Workforce* project directly addresses three imperatives identified in the *National Innovation and Science Agenda*, namely improved STEM education, enhanced industry collaboration and increased female and ATSI participation in the STEM workforce. The success of the project will provide significant and enhanced commercial return on the public investment in research training in the mathematical sciences.

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.



AMSI

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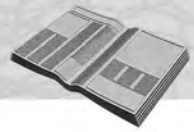

News

General News

The Asia-Pacific Consortium of Mathematics-for-Industry (APCMfI)

In order to enhance the image and importance of the Mathematics-for-Industry concept, while taking advantage of the common time zone in the Asia-Pacific region, the idea of having an Asia-Pacific Consortium of Mathematics-for-Industry (APCMfI) was launched in early 2014. The *Gazette* [42, no. 2 (2014) 85–86] previously included a report on planning for APCMfI. We can now announce that the APCMfI has a website (http://apcmfi.org/) where one can join as a member. The benefits of being a member, industrial mathematics activities, etc. are listed.

In a nutshell, the image, role and importance of mathematics to society depends crucially on enhancing the employment opportunities for mathematics students. Key goals of APCMfI include

(i) the enhancement of such employment opportunities throughout the Asia-Pacific region;

(ii) exploration for and exploitation of new mathematical opportunities arising from collaboration between industrial, scientific, technological and social science partners;

(iii) examining how the results of modern developments in fundamental and abstract mathematics generate new insight about the solution of real-world problems.

The two way interaction between industry and mathematics is highlighted by the Mathematics-in-Industry and Mathematics-for-Industry (MfI) activities, with the former responding with mathematics to the questions and needs of industry, while a key focus for the latter is preparing mathematics students to undertake employment in industry.

Members and potential members are encouraged to visit the website for further details.

Completed PhDs

Federation University

- Dr Ghasem Ezzati, *Reliability-based design optimisation methods in large scale systems*, supervisors: David Yost and Sid Kulkarni.
- Dr Mahdi Zarei, *Development and evaluation of optimization based data mining techniques for analysis of brain data*, supervisors: Zari Dzalilov and Adil Bagirov.

Monash University

- Dr Ahsan Jaleel, *Constructing free resolutions of cohomology algebras*, supervisor: Andrew Percy (School of Applied Sciences & Engineering, Gippsland campus).

RMIT University

- Dr Jacobien Carstens, *Topology of complex networks: models and analysis*, supervisors: Kathy Horadam and Asha Rao.
- Dr Martijn Van Der Merwe, *An optimisation approach for assigning resources to defensive tasks during wildfires*, supervisors: John Hearne, Melih Ozlen and James Minas.

University of New South Wales

- Dr Boris Beranger, *Modelling the dependence structure of multivariate and spatial extremes*, supervisor: Scott Sisson.
- Dr Jieyi (Amy) He, *Detecting and modelling serial dependence in non-Gaussian and non-linear time series*, supervisor: William Dunsmuir.
- Dr Thomas Watson, *On aspects of numerical ergodic theory — stability of Ulam's method, computing Oseledets subspaces, and optimal mixing*, supervisor: Gary Froyland.

Awards and other achievements

University of Adelaide

- Elder Professor Mathai Varghese will deliver the 2016 Herbert Howe Lecture series at the University of Denver on 19 May.
- Elder Professor Mathai Varghese was appointed Associate Editor, *Journal of Geometry and Physics* on 1 February 2016.
- David Skene won the Tuck Fellowship recently; see http://iwwwfb.org/Tuck/tuckrecipients.htm.

University of Sydney

- Adrianne Jenner jointly won the T.M. Cherry Prize for the best student talk at the ANZIAM 2016 Conference in Canberra.
- Padraic Gidney, a Vacation Research Scholar, won the prize for best talk on the second day at AMSI's Big Day In in Melbourne.

Appointments, departures and promotions

Australian National University

- Dr David Ridout departed on 13 March, to take up a position at the University of Melbourne.

Monash University

New staff

- Dr Ivan Guo
- Dr Jim Woodcock
- Dr Rajko Nenadov
- Dr Michael Payne

RMIT University

- Dr Haydar Demirhan has been appointed Lecturer in Analytics. He joins RMIT from Hacettepe University, Turkey, where he was an associate professor of statistics. His main research topics include Bayesian inference, categorical data analysis, cryptographic randomness, and statistical models for environmental problems. He has published more than 30 peer-reviewed research articles on Bayesian analysis of categorical data, Bayesian model selection, Bayesian approaches in quality control, group sequential test designs, Monte Carlo simulation, and solar radiation modelling. He has also expertise in statistical computing; he has published two R-packages and related peer-review articles. He brings his experience in undergraduate and postgraduate teaching in Bayesian statistics, statistical methods, Monte Carlo simulation, and probability theory.

University of Melbourne

New staff:

- Dr Anita Ponsaing (Research Fellow)
- A/Prof Stephen Leslie (Associate Professor)
- Dr Damjan Vukcevic (Research Fellow)
- Dr Allan Motyer (Research Fellow)
- Dr Joyce Zhang (Lecturer)
- Dr David Ridout (Lecturer)
- Mr Eric Zhou (Research Fellow)
- Ms Inna Lukyanenko (Research Fellow)

Departed staff:

- Ms Elizabeth Bailey (Transition Specialist)

University of New South Wales

New staff:

- Daniel Mansfield (PhD from UNSW) has been appointed as associate lecturer
- Joshua Capel (PhD from UNSW) has been appointed as associate lecturer
- Jia Deng, who has a PhD from the University of Calgary, Canada, has been appointed as a lecturer in the Department of Statistics
- Renata Rendek, who has a PhD in Mathematics from UTS, Sydney, has been appointed as a lecturer in the Department of Statistics
- Our teaching fellow for 2016 is Paul Hancock, who comes to UNSW for the year from Woonona High School

New postdocs:

- Boris Beranger, PhD UNSW (supervisor: Scott Sisson)
- Paulina Cetina-Heredia, PhD in Oceanography, James Cook University (supervisor: Moninya Roughan)
- ShiShivanesh Rao, PhD in Physical Oceanography, Earth Sciences, University of New Hampshire (supervisor: Moninya Roughan)
- Wesley Brooks, PhD in Statistics, University of Wisconsin (supervisor: David Warton)
- Loic Thibaut, PhD in Marine Biology, James Cook University (supervisor: David Warton)
- Davor Dragicevic, PhD in Mathematics, Instituto Superior Tecnico, Portugal (supervisor: Gary Froyland)
- Maike Massierer, PhD in Mathematics, Universitat Basel, Switzerland (supervisor: David Harvey)
- Huy Chieu Nguyen, PhD in Mathematics, Instute of Mathematics, Vietnam (supervisor: Jeyakumar)
- Tristan Sasse, PhD UNSW (supervisor: Mark Holzer)
- Kosuke Suzuki, PhD Mathematical Sciences, University of Tokyo (supervisor: Josef Dick)
- Takehito, Yoshiki, PhD in Mathematical Sciences, University of Tokyo (supervisor: Josef Dick)
- Dinh Thi Tran, PhD in Mathematics, La Trobe University (supervisor: John Roberts)

University of Sydney

- Sheehan Olver has been promoted to Associate Professor.

University of Western Australia

- Dr Gabriel Verret finished on 5 April 2016, to start a position at University of Auckland.

University of Wollongong

- Dr Nathan Brownlowe and Dr Ivan Guo have left the university.

New Books

Federation University

Zhang, J. (2015). *Molecular Structures and Structural Dynamics of Prion Proteins and Prions: Mechanism Underlying the Resistance to Prion Diseases.* Springer, Focus on Structural Biology, Volume 9. ISBN: 978-94-017-7317-1 (print) 978-94-017-7318-8 (online).
http://link.springer.com/book/10.1007%2F978-94-017-7318-8

University of Western Australia

Burness, T.C. and Giudici, M. (2016). *Classical Groups, Derangements and Primes.* Australian Mathematical Society Lecture Series: 25. Cambridge University Press, Cambridge. ISBN: 978-1-107-62944-8.

Conferences and Courses

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

ANU Maths Day 2016

Date: 20 May 2016
Venue: Melville Hall, Ellery Crescent, The Australian National University

Young maths enthusiasts from across the region are invited to battle it out in a test of mind and muscles at ANU Maths Day. In teams of five, year 12 students take part in mathematical challenges designed to build teamwork skills and promote a love of maths. The day is divided into four challenges:

- a group of story problems
- a swiss 'find the rule' problem
- a cross number puzzle
- and the day's highlight, the relay — a test of brainpower and physical stamina.

ANU Maths Day has been running in the ACT since 1982. The University's competition includes contestants from schools in Canberra, Wollongong, the South Coast, Southern Highlands and Sydney. The day gives the students a chance to meet another 160 like-minded young people who are into mathematics, which is particularly important for people from smaller schools.

ANU Maths Day isn't all about being the cleverest or the brightest. Activities are formulated to ensure that everyone can have a go and have fun while taking part in some healthy and rigorous competition.

STEMS 2016

Dates: 2–3 June 2016
Venue: University of Technology Sydney
Web: STEMS2016.com

The Statistical Society of Australia (SSA), via its Statistics Education Section, is hosting a two-day colloquium and workshop to develop a platform for the transformation of Statistics Education in Australia, in response to an increasingly massive demand for statisticians and an equally massive shortfall in supply. Please consider the program at the website; it includes speakers and representatives from: Harvard University; Office of Prime Minister and Cabinet; Commonwealth Bank of Australia; Qantas; ACARA, ACEMS, ABS, AMSI, NSW BOSTES, SSA; and will include a Panel Discussion session including Q&A floor discussion, followed by exploration of ideas and a workshop to develop and initiate a plan of action for progressing Statistics education in Australia.

Associated FREE public seminar: 'National and local initiatives in Statistics Education', 1 June
Speaker: Dr Peter Howley
Details: https://stems2016.com/pre-colloquium-seminar/

MATRIx: Higher structures in geometry and physics

Dates: 5–18 June 2016
Venue: University of Melbourne, Water Street, Creswick, Victoria
Web: http://www.matrixatmelbourne.org.au/events/higher-structures-in-geometry-and-physics/

Associated workshop: Higher categories, higher operads and properads, 6–10 June 2016.

For recent updates, please see the website.

Probabilistic and Extremal Combinatorics Downunder

Dates: 13–17 June 2016
Venue: Monash University, Melbourne
Web: http://users.monash.edu.au/~davidwo/Downunder/

For further details, please see *Gazette* 43(1) p. 60.

MATRIx: Winter of disconnectedness

Dates: 27 June–8 July 2016
Venue: University of Melbourne, Creswick campus, Water Street, Creswick, Victoria
Web: http://www.matrixatmelbourne.org.au/events/winter-of-disconnectedness/

Associated event: Disconnected Groups, 27–30 June 2016.

For further details, please see *Gazette* 43(1) p. 60.

USMaC 2016: Universal Structures in Mathematics and Computing

Dates: 27 and 28 June 2016
Venue: La Trobe University, city campus (Collins Street, Melbourne)
Web: http://usmac.ltumathstats.com

This workshop aims to bring together researchers working in category theory, logic, universal algebra, relational and graph theoretic foundations for computer science and mathematics in order to highlight recent advances in these fields and to facilitate dialogue between the different camps. Of particular interest is work which spans two or more of these areas.

Keynote Speakers:

- Rob Goldblatt (Victoria University of Wellington)
- Walter Guttmann (University of Canterbury)
- Michael Johnson (Macquarie University)
- Tim Stokes (University of Waikato)
- Yoshihiro Mizoguchi (Kyushu University)

Please see the workshop website for futher details on registration (which is free), submission of talks, topics of interest and accommodation details. Limited travel support is available for students.

The workshop is sponsored by La Trobe University's Discipline Research Program in Mathematical and Computing Sciences.

BAM 2016: 4th Biarri Applied Mathematics Conference

Dates: 28–29 June 2016
Venue: QUT, Brisbane
Web: http://bamconf.com/

For further details, please see *Gazette* 43(1) p. 61, visit the website, or enquire through bam@biarri.com.

Mathematics-in-Industry for New Zealand-Study Group: 2016

Dates: 4–8 July 2016
Venue: Victoria University of Wellington, Wellington, New Zealand
Web: http://www/minz.org.nz

The MINZ-SG 2016 meeting is jointly held with counterparts in Japan, thanks to the support of the Japanese Society for the Promotion of science. There are now six problem challenges expected and details are appearing on the website. One is from Japan.

The event is free and plenty of fun. Invited speakers include Professor Andrew Fowler of Limerick/Oxford, Dr Mary Quinn, CEO of Callaghan Innovation, PVC Science VUW Mike Wilson, and Japanese Ambassador Takata. More background can be seen on the YouTube video https://www.youtube.com/channel/UCBdlFHZ1WA4kiy3WQABUGjA.

Winter School on Health and Environmental Modelling

Dates: 4–15 July 2016
Venue: The University of Queensland
Web: http://amsi.org.au/ws

Registration closing date is 19 June.

For recent updates, please see the website.

The 13th Australasian Conference on Mathematics and Computers in Sport

Dates: 11–13 July 2016
Venue: City Conference Centre of Victoria University, Flinders Street, Melbourne
Web: http://www.anziam.org.au/The+13th+Australasian+Conference+on+Mathematics+and+Computers+in+Sport

For further details, please see the website or *Gazette* 43(1) pp. 62–63.

MATRIx: Approximation and optimisation

Dates: 11–15 July 2016
Venue: University of Melbourne, Creswick campus
Web: http://www.matrixatmelbourne.org.au/events/approximation-and-optimisation-3/

Associated event: Mathematical Optimisation Down Under (MODU2016).
Dates: 18–22 July 2016
Venue: Radisson Hotel, 380 William Street, Melbourne, Victoria
Web: http://www.modu2016.org/

For further details, please see the websites or *Gazette* 43(1) pp. 64–65.

Ergodic Theory and its Applications

Dates: 18–22 July 2016
Venue: School of Mathematics and Statistics, The University of Sydney
Web: http://www.maths.usyd.edu.au/ET2016/

For further details, please see the website or *Gazette* 43(1) pp. 64–65 or contact one of the organisers, Alexander Fish (alexander.fish@sydney.edu.au) and Mumtaz Hussain (mumtaz.hussain@newcastle.edu.au).

MATRIx: Refining C*-algebraic invariants for dynamics using KK-theory

Dates: 18–29 July 2016
Venue: University of Melbourne, Creswick campus
Web: http://www.matrixatmelbourne.org.au/events/refining-c-algebraic-invariants-for-dynamics-using-kk-theory/

Associated event: KK Theory and Dynamics
25–29 July 2016

For further details, please see the website or *Gazette* 43(1) p. 66.

Geometry at ANU

Venue: The Australian National University
Dates: 15–26 August 2016
Web: http://research.amsi.org.au/events/event/geometry-at-anu/

For further details, please see the website or *Gazette* 43(1) p. 66.

Topological Matter, Strings, and K-theory

Dates: 5–9 September 2016
Venue: The University of Adelaide
Web: http://research.amsi.org.au/events/event/topological-matter-strings-and-k-theory/

For further details, please see the website or *Gazette* 43(1) p. 67.

Boden Research Conference 2016

Animal, Vegetal, Mineral? Emergence and Function of Complex Shapes in Self-Assembly and Biological Cells

Dates: 18–23 September 2016
Venue: Cave House Hotel, Yallingup, Western Australia
Web: http://animal-vegetal-mineral.org/

Complex nanostructures abound in biological tissue and related synthetic soft materials. These convoluted forms remain largely unexplored, both in terms of how and why they emerge, and undoubtedly involve interplay of biology in vivo with physicochemical factors at work *in vitro*.

'Animal Vegetal Mineral' will be an interdisciplinary forum to discuss and attempt to demarcate the similarities and differences between structure formation mechanisms in biological materials and synthetic soft self-assembled materials. We invite and welcome interested scientific researchers from biology, chemistry, materials science, physics and mathematics to join us for an open-minded exploration of the relations between shape, structure formation and function in biological tissue and nano- and mesostructured materials.

Topological Matter, Strings, K-theory and related areas

Dates: 26–30 September 2016
Venue: Adelaide
Web: http://www.iga.adelaide.edu.au/workshops/WorkshopSep2016/

For further details, please see the website.

ATIS 2016, the 7th International conference on Applications and Techniques in Information Security

Dates: 26–28 October 2016
Venue: CQU, Cairns
Web: http://www.atis2016.conferences.academy/

Deakin University and Central Queensland University are jointly organising this conference.

Papers are due by 1 July 2016, and, upon acceptance, will be published in Springer's Communications in Computer and Information Science Series.

Mathematical Methods for Applications

Date: 11–14 November 2016
Venue: Hangzhou, China
Web: http://www.anziam.org.au/ZPAMS

For further details, please see the website or *Gazette* 43(1) p. 68.

International Conference on Nonlinear Partial Differential Equations

Dates: 21–25 November 2016
Venue: University of New England, School of Science and Technology
Web: http://sydney.edu.au/science/maths/u/PDESeminar/nlpde2016/

For further details, please see the website or *Gazette* 43(1) p. 68.

Computational Techniques and Applications Conference (CTAC) 2016

Date: 27–30 November 2016
Venue: Monash (Caulfield campus)
Web: http://www.monash.edu/ctac2016/

Important dates:

- Registration open on 9 May
- Early-bird registration deadline: 30 September
- Registration closing date: 18 November
- Deadline for abstract submission: 28 October

See the conference website for more information.

Organisers: Simon Clarke and Jerome Droniou

BioInfoSummer 2016

Dates: 28 November to 2 December 2016
Venue: The University of Adelaide
Web: http://amsi.org.au/events/event/bioinfosummer-2016/

The BioInfoSummer series introduces bioinformatics and mathematical and computational biology to advanced undergraduate and postgraduate students, researchers and professionals working in the fields of mathematics, statistics, computer science, information technology, complex systems analysis, and biological, chemical and medical sciences and engineering.

Themes that will be discussed include:

- Bionformatics introduction for Biologists and Mathematicians
- Basics of high dimensional data and multivariate analysis
- Analysing long read (third generation) sequencing data and eukaryotic whole genome sequencing
- RNAseq experimental design and analysis
- Coding for bioinformatics

MATRIx: Interactions between topological recursion, modularity, quantum invariants and low-dimensional topology

Dates: 28 November to 23 December 2016
Venue: University of Melbourne, Water Street, Creswick, Victoria

Associated events:

- Quantum Invariants and Low-dimensional Topology
  14–17 December 2016
- Topological Recursion and Modularity
  19–23 December 2016
  Web: http://www.matrixatmelbourne.org.au/events/interactions-between-topological-recursion-modularity-quantum-invariants-and-low-dimensional-topology/

For further details, please see the website or *Gazette* 43(1) p. 69.

Maths Fest Australia 2016

Dates: 28 November to 16 December 2016
Venue: Canberra

Incorporating

- Advances in Ergodic Theory, Hyperbolic Dynamics, and Statistical Laws
  Dates: 28 November to 2 December 2016
- 60th Annual Meeting of the Australian Mathematical Society
  Dates: 5–8 December 2016
  Venue: The Australian National University
- Nonlinear and Geometric Partial Differential Equations
  Dates: 9–13 December 2016

Details of these three conferences are listed individually below.

Advances in Ergodic Theory, Hyperbolic Dynamics & Statistical Laws

Dates: 28 November to 2 December 2016
Venue: ANU, Canberra
Web: http://research.amsi.org.au/maths-fest-australia-2016/

Part of Maths Fest Australia 2016, this workshop will bring together experts in probabilistic and deterministic dynamics, as well as in applications, from around the globe this first workshop will allow transfer and exploitation of ideas and set the research agenda for the coming years.

Speakers:

- Viviane Baladi* (CNRS, France)
- Beniamin Goldys (Univ. Sydney)
- Andrew Hassell (ANU)
- Carlangelo Liverani (Rome Tor Vergata, Italy)
- Maria José Pacifico (UFRJ, Brazil)
- Mark Pollicott (Univ. Warwick, UK)
- Kavita Ramanan* (Brown University, USA)
- Jana Rodriguez Hertz (IMERL, Uruguay)
- Andrew Stuart (Univ. Warwick, UK)
- Eric Vanden-Eijnden* (Courant Inst. New York, USA)
- Amie Wilkinson (Univ. Chicago, USA)

*To be confirmed.

Workshop on Integrable Systems 2016

Dates: 1–2 December 2016
Venue: University of Sydney
Web: http://wp.maths.usyd.edu.au/igs/workshops/integrable-systems-2016/

This workshop is being organised by Nalini Joshi, Christopher Lustri, Milena Radnovic, Yang Shi, and Stephanie Swanson.

60th Annual Meeting of the Australian Mathematical Society

Dates: 5–8 December 2016
Venue: Canberra
Web: http://maths.anu.edu.au/events/austms-meeting-2016

Part of Maths Fest Australia 2016, the 60th annual meeting of the Australian Mathematical Society will be held by the Mathematical Sciences Institute at the Australian National University from the 5–8 December 2016.

Invited Speakers:

- Miranda Cheng, University of Amsterdam
- Alessio Figalli, ETH Zurich
- Kavita Ramanan, Brown University
- Simon Levin, Princeton University
- Andre Neves, Imperial College London
- Tomoyuki Arakawa, Kyoto University

- Adelle Coster, University of New South Wales
- Georg Gottwald, The University of Sydney
- Kari Vilonen*, Northwestern University
- Lesley Ward, University of South Australia
- Nicholas Wormald, Monash University
- Matthew Kennedy, University of Waterloo

*To be confirmed.

Organising Committee:

- Vigleik Angeltveit, Australian National University
- Joan Licata, Australian National University
- Brittany Shoard, Australian National University
- John Urbas, Australian National University (Chair)

Program Committee:

- Vladimir Gaitsgory, Macquarie University
- John Urbas, Australian National University (Director)
- Yihong Du, Univeristy of New England
- Frances Kuo, University of New South Wales
- Anthony Licata, Australian National University
- Giang Nguyen, The University of Adelaide
- Todd Oliynyk, Monash University
- Sheehan Olver, The University of Sydney
- Arun Ram, University of Melbourne

23rd Australian Statistical Conference 2016 in conjuction with 14th Australasian Data Mining Conference (AusDM) and 9th Australian Conference on Teaching Statistics (OZCOTS)

Dates: 5–9 December 2016
Venue: Hotel Realm, Canberra
Website: www.asc2016.com.au

For further details, please see the website or *Gazette* 43(1) p. 69.

Nonlinear & Geometric Partial Differential Equations

Dates: 9–13 December
Venue: ANU, Canberra
Web: http://research.amsi.org.au/maths-fest-australia-2016/

Part of Maths Fest Australia 2016, this workshop will gather researchers in the areas of geometric analysis and nonlinear and geometric partial differential equations, ranging from geometric variational problems to geometric flows and aspects of geometric PDE.

Speakers:

- Binglong Chen (Sun Yat-sen Univ, China)
- Jaigyoung Choe (KIAS, Korea)
- Alessio Figalli (ETH Zurich, Switzerland)
- Aiyana Fraser (Univ. British Columbia, Canada)
- Nicola Fusco (Uni. Naples Federico II, Italy)

- Gerhard Huisken (Tbingen/Oberwolfach, Germany)
- Fernando Coda Marques (Princeton Univ., USA)
- André Arroja Neves (Imperial College London, UK)
- Duong Phong (Columbia Univ, USA)
- Yoshihiro Tonegawa (Tokyo Inst. of Technology, Japan)
- Mu-Tao Wang (Columbia Univ., USA)
- Guofang Wei (UC Santa Barbara, USA)

ANZAMP 5th annual meeting

Dates: 1–3 February 2017
Venue: University of NSW
Web: http://www.anzamp.austms.org.au/events/

More information to come.

ANZIAM 2017

Dates: 5–9 February 2017
Venue: Hahndorf Resort, South Australia

Applied Probability at the Rock: An international workshop in celebration of Phil Pollett's 60th birthday

Dates: 17–21 April 2017
Venue: Ayers Rock Resort

AustMS 2017

Dates: 11–14 December 2017
Venue: Macquarie University

Vale

Robert Leonard Bish

Robert Leonard Bish of the Aeronautical and Maritime Research Laboratory, Mathematician, Materials Researcher and longstanding AustMS member, passed away on 14 February. An obituary appears in the Fairfax media, http://www.theage.com.au/comment/obituaries/despite-setbacks-maths-and-metal-researcher-kept-doing-what-he-loved-20160424-godzd5.html.

Joseph Mark Gani

With sadness we inform members of the death on 12 April of Professor Joe Gani, a Foundation Member of the Society and President from 1978 to 1980. An obituary will appear in a subsequent issue. Two interviews he gave are available at https://www.science.org.au/learning/general-audience/history/interviews-australian-scientists/interview-professor-joe-gani and http://www.jstor.org/tc/accept?origin=/stable/pdf/2246194.pdf.

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 David Allen; Edith Cowan; 1 August 2015 to 31 July 2016; statistics; USN; Shelton Peiris

Prof Fusheng Bai; Chongqing Normal University; 11 July to 16 September 2016; optimisation; FDU; Alex Kruger

Ms Clarissa Barco; Universidade Federal de Sao Carlos, Brazil; 4 April to 28 May 28 2016; UMB; Alysson Costa

Dr Udo Baumgartner; 7 August to 15 September 2016; pure; USN; Jacqui Ramagge

Prof Helen Byrne; Oxford; 17 July to 18 August 2016; applied; USN; Mary Myerscough

A/Prof Eric Chesebro; University of Texas at Austin; 1 March 2016 to 28 May 2016; pure maths; USN; Stephan Tillmann

Ms Giulia dal Verme; Università degli Studi di Milano-Bicocca, Milano, Italy; 15 September to 14 December 2016; pure; USN; Jacqui Ramagge

Prof Aris Daniilidis; University of Chile; 17–29 July 2016; optimisation; RMIT; Vera Roshchina

Mr Sayed Ahmadreza Raeisi Dehkordi; University of Isfahan, Iran; 16 January to 15 July 2016; optimisation; FDU; Adil Bagirov

Dr Wei Deng; Shanghai Maritime University, China; 15 December 2015 to 14 December 2016; optimisation; FDU; David Gao

Ms Soodabeh Asada Dezaki; Shahrekord University, Iran; 20 January to 20 July 2016; optimisation; FDU; Adil Bagirov

Prof Reinier Díaz Millán; Federal Institute of Goias, Goiania, Brazil; 1 January 2016 to 31 December 2016; optimization, variational inequality problem, inclusion problem, splitting methods; USA; Regina S. Burachik

Dr Philip Ernst; Rice University, USA; 1–31 May 2016; UMB; Peter Taylor

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

Dr Cecile Hardouin; University of Paris at Nanterre; 25 January to 30 June 2016; spatial statistics; UOW; Noel Cressie

Ms Tatiana Hessab; URFJ, Brazil; 1 March to 10 August 2016; UMB; David Balding

Mr Cheng Hu; Shandong University; 20 November 2015 to 19 May 2016; statistics; Qiying Wang

Dr Genggeng Huang; Shanghai Jiao Tong University; 10 October 2015 to 9 October 2016; ANU; Xu-Jia Wang

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

Mr Felix Huber; University of Stuttgart; 1 April to 1 September 2016; UMB; Professor Markus Hegland

Prof Kenji Iohara; Lyon; 14 October to 15 November 2016; Pure; USN; Gus Lehrer

Dr Napsu Karmitsa; Turku University, Finland; 2 January to 24 December 2016; optimisation; FDU; Adil Bagirov

Prof Jibin Li; Zhejiang Normal University, Jinhua, China; 25 September to 15 October 2016; SUT; nonlinear science and applications, dynamical systems; Tonghua Zhang

A/Prof Jingjian Li; Guangxi University P.R. China; January 2016 to January 2017; UWA; Cai Heng Li

Prof Jeff Linderoth; University of Wisconsin-Madison; 6–29 July 2016; integer programming and combinatorial optimisation; RMIT; Andrew Eberhard

Dr Xia Liu; Henan Normal University, China; 1 September 2016 to 31 August 2017; SUT; applied mathematics, dynamical systems; Tonghua Zhang

Prof Feng Luo; Rutgers University; 1–31 May 2016; pure; USN; Stephan Tillmann

Dr Tristan Mary-Huard; UMR AgroParisTech, France; 1 April to 31 August 2016; UMB; David Balding

A/Prof Kelly McKinnie; University of Montana; 1 March to 28 May 2016; pure; USN; Stephan Tillmann

Dr Dinkara Muthiah; University of Alberta; 28 April to 12 May 2016; pure; USN; Oded Yacobi

A/Prof Martin Olsen; Aarhus University, Denmark; 1–6 May 2016; combinatorial optimisation; RMIT; Marc Demange

Prof Michael Pecht; University of Maryland; 14 June to 26 July 2016; UWA; Ed Cripps and Melinda Hodkiewicz

Dr Jiangyan Peng; University of Electronic Science and Technology of China; 15 October 2015 to 14 October 2016; stats; USN; Qiying Wang

Prof Joan Porti; 24 April to 5 May 2016; Pure; USN; Stephan Tillmann

Dr John Power; University of Bath; 13 July to 29 August 2016; category theory and its applications in computer science; MQU; richard.garner@mq.edu.au

A/Prof Héctor Ramírez; University of Chile; 29 May to 5 June 2016; optimisation; RMIT; Vera Roshchina

Mr James Reoch; Adelaide; 3 August 2015 to 31 December 2017; applied; USN; Peter Sehoon Kim

Dr Salarian Mohammad Reza; Kharazmi University, Iran; 20 June to 11 July 2016; UMB; Sanming Zhou

Prof Steve Rosenberg; Boston University; August 2015 to June 2016; differential geometry in finite and infinite dimensions, particularly with applications to/ from mathematical physics; UAD; srmathbu@gmail.com

Mr Landir Saviniec; University of Sao Paolo, Brazil; 1 November 2015 to 31 October 2016; UMB; Alysson Costa

Dr Martin Schmidt; University of Mannheim; 13 June to 15 July 2016; pure; USN; Emma Carberry

A/Prof Ilya Shvartsman; Penn State Harrisburg; 5 January to 30 June 2016; optimal control theory, nonlinear and nonsmooth analysis; MQU; Vladimir Gaitsgory

A/Prof Scott Sisson; UNSW; 4 April to 30 June 2016; stats; USN; Michael Stewart

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

Ms Ying-Ying Sun; Shanghai University; 9 September 2015 to 1 September 2016; applied; Nalini Joshi

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

Dr Daniele Valeri; Yau Mathematical Sciences Center; 29 April to 29 May 2016; pure; USN; Alexander Molev

A/Prof Cristian Virdol; Yonsei University; 14 July to 29 August 2016; pure; USN; Laurentiu Paunescu

Ms Jun Wang; University of Science and Technology of China; 1 October 2015 to 1 March 2017; ANU; Ben Andrews

Prof Charles Weibel; Rutgers University, USA; 1–16 May 2016; UMB; Marcy Robertson

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

Prof Zhiyou Wu; Chongqing Normal University; 11 July to 16 September 2016; optimisation; FDU; Alex Kruger

Dr Ying Xu; Hefei University of Technology; 1 September 2015 to 31 August 2017; pure; USN; Ruibin Zhang

Dr Dongyong Yang; University of Xiamen, Xiamen, China; July 2015 to June 2016; harmonic analysis; MQU; Xuan Duong

A/Prof Hengyun Yang; Shanghai Maritime University; 16 January 2016 to 15 January 2017; pure; USN; Ruibin Zhang

Dr Enki Yoo; State University of New York at Buffalo; 18 January to 30 June 2016; geographic information science; UOW; Noel Cressie

Dr Junyong Zhang; Beijing Institute of Technology; 1 September 2015 to 31 August 2016; ANU; Andrew Hassell

Mr Yang Zhang; Uni of Science and Technology, China; 1 October 2015 to 30 September 2017; pure; USN; Ruibin Zhang

Prof Jiandong Zhao; Ludong University, China; 1 June to 30 November 2016; differential equations and mathematical biology; SUT; Tonghua Zhang

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

Election of officers and ordinary members of Council

Officers of Council

The present Officers of the Society are:

President: T.R. Marchant
President-Elect: K.A. Smith-Miles
Vice-President: J.A.G. Roberts
Secretary: P.J. Stacey
Treasurer: A. Howe
Vice-President (Chair of ANZIAM): M.R. Myerscough
Vice-President (Chair of ANZAMP): T.M. Garoni

According to Paragraph 34 (i) of the Constitution, Professor T.R. Marchant will continue in office as the Immediate-Past-President, and Professor K.A. Smith-Miles will move from President-Elect to President, after the AGM in December 2016. According to Paragraph 34 (iii), the positions of Secretary and Treasurer will be appointed by Council at its December 2016 meeting.

Nominations are invited for one Vice-President for the Session commencing after the Annual General Meeting to be held in December 2016. According to Paragraph 34 (ii) of the Constitution, J.A.G. Roberts is eligible for re-election.

Ordinary Members of Council

The present elected Ordinary Members of Council are:

1. Members whose term of office expires after the AGM in 2016:
   S. Morrison J.G. Sumner
2. Members whose term of office expires after the AGM in 2017:
   J. de Gier H.S. Sidhu A. Sims
3. Members whose term of office expires after the AGM in 2018:
   N.G. Bean A. Devillers D.M. Donovan

Accordingly, nominations are invited for three positions as Ordinary Members of Council, who shall be elected for a term of three consecutive sessions. Note that according to Paragraph 34(iv) of the Constitution, S. Morrison and J.G. Sumner are not eligible for re-election at this time as Ordinary Members. According to paragraph 35 of the Constitution, a representative from Tasmania will be required, to ensure that the Officers and elected members of Council include residents from all the States and the ACT.

To comply with Paragraphs 61 and 64 of the Constitution, all nominations should be signed by two members of the Society and by the nominee who shall also be a Member of the Society.

Nominations should reach the Secretary no later than Friday 29 July 2016.

Alternatively, members are encouraged to send informal suggestions to the Nominations and Publications Committee, by emailing the Secretary at Secretary@austms.org.au.

For the information of members, the following persons are currently ex-officio members of Council for the Session 2015–2016.

Vice President (Annual Conferences): V. Gaitsgory
Representative of ANZIAM: J. Piantadosi
Representative of ANZAMP: V. Mangazeev (from December 2016)
Public Officer of AustMS and AMPAI: P.J. Cossey
Chair, Standing Committee on Mathematics Education: B.I. Loch
AustMS member elected to Steering Committee: P.J. Forrester

Editors: S.A. Morris/D.T. Yost (Gazette)
J.H. Loxton (Bulletin)
R.R. Moore (Electronic Site)
J.M. Borwein/G.A. Willis (Journal of AustMS)
C.E. Praeger (Lecture Series)
A.P. Bassom /G. Hocking (ANZIAM Journal)
A.J. Roberts (ANZIAM Journal Supplement)

The Constitution is available from the Society's web pages, at http://www.austms.org.au/AMSInfo/Const/amsconst.html.

Nominations to Council Subcommittees

The Nominations and Publications Committee makes recommendations to Council on membership of Council subcommittees and Editors of the Society's publications. In carrying out its responsibilities, the Committee seeks to foster diversity of representation.

On behalf of the committee, I now call for expressions of interest from members willing to serve in any positions that may become open next year or in future years. The subcommittees of Council for which nominations are sought from Society members from time to time are the AustMS Medal Committee, the George Szekeres Medal Committee, the Gavin Brown Prize Committee, the Mahler Lecturer Committee, the Fellowship Committee, the Accreditation Committee, the

Student Conference Support Committee, the Standing Committee on Mathematics Education, the Accreditation Committee and the Membership and Marketing Committee. In addition, Early Career Representatives, who organise Early Career Workshops, are nominated by the committee.

Some of the positions require particular expertise or experience and it will therefore assist the committee if those willing to serve briefly indicate the subcommittees for which they consider themselves best suited and their relevant experience.

The 2017 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

Nominations for the AWARD can be made by any member of ANZIAM other than the nominee or members of the Selection committee. A nomination should consist of a brief C.V. 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 Yvonne Stokes (yvonne.stokes@adelaide.edu.au), Chair of the Selection Panel, by *7th November 2016*.

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

The 2017 E.O. Tuck Medal: call for nominations

In honour of the late Ernest Oliver Tuck, FAustMS, FTSE and FAA, ANZIAM has instituted a mid-career award for outstanding research and distinguished service to the field of Applied Mathematics. At most one award will be made biennially, but only to a candidate of sufficient merit. No person can receive more than one such award and previous winners of the ANZIAM medal are ineligible. The award will not be offered in the same year as the ANZIAM medal. The selection criteria for the award are:

1. Outstanding research, relative to opportunity, in Applied and/or Industrial Mathematics, where a significant proportion of the research work has been carried out in Australia and/or New Zealand.
2. Distinguished service in the field of Applied Mathematics. Service in ANZIAM related activities will be highly regarded.
3. On 1 January in the year in which the award is made, the recipient will have normally had their PhD conferred more than ten and less than twenty years ago (see note 3 below).
4. Membership of ANZIAM for at least the five calendar years preceding the year in which the AWARD is made. Backdating of membership is not acceptable.

Notes:

1. In criterion 1 the research portfolio will be assessed relative to opportunity. Any significant teaching and administrative responsibilities will be considered when assessing the volume of a candidate's research output and contribution.
2. ANZIAM considers it highly desirable that its members advance the profession into the future. The selection panel can consider the potential of the candidate to the discipline (for example, via their ability to be awarded prestigious research fellowships).
3. Any exceptional circumstances should be forwarded to the Executive Committee to assess eligibility; they will normally consider the types of career interruptions allowed by the ARC in their research fellowship guidelines.

Nominations:

Nominations for the AWARD can be made by any member of ANZIAM other than the nominee or members of the Selection committee. A nomination should consist of a brief C.V. of the nominee together with the nominee's list of publications, a one-page resumé of the significance of the nominee's research and a

one-page resumé of the nominee's service contribution. Nominations should be forwarded in confidence, electronically in pdf format, to Professor Kerry Landman (kerryl@unimelb.edu.au), Chair of the Selection Panel, by *7 November 2016*.

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

AustMS Accreditation

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

- Professor R. Hartley of the Australian National University,
- Associate Professor B.I. Loch of the Swinburne University of Technology,
- Professor R.C. Williamson of NICTA.

Mr I. Jerbi has been accredited as a Graduate Member (GAustMS).

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

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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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