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The Australian Mathematical Society

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

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

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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 42(3), 42(4) and 42(5) of the *Gazette* are 1 June, 1 August and 1 October 2015.

Volume 42 Number 2 **2015**

Editorial

Sid and I welcome you to another issue of the *Gazette*.

Most *Gazette* readers will believe in the relevance of mathematical sciences, and consequently of mathematical education, to national prosperity. How do we persuade the general public of this, or our leaders to make decisions which recognise it? The economic contribution of mathematical and physical sciences was recently estimated at about $145 billion annually, in a report commissioned by the Australian Academy of Science and the Office of the Chief Scientist. Rather than provide more details here, I can do no better than refer you to Nalini Joshi's NCMS column on this important topic.

Some in the private sector are also concerned about the declining pipeline of young people who choose to study advanced mathematics subjects, and the effects of this on work readiness of the next generation. Putting their money where their mouth is, the BHP Billiton Foundation is contributing $22 million over five years, to fund AMSI's *Choose Maths* program, which aims to turn around the commonly held misconception that mathematics and cognate areas are unsuitable study and career choices for the half of our population who happen to be female. I was privileged to attend the launch of *Choose Maths* in Melbourne on April 28.

Speaking at the launch, Andrew Mckenzie, CEO of BHP Billiton, said

> Australian industry knows that STEM professionals are vital to our future prosperity, national productivity and global competitiveness.
>
> Any increase in STEM participation is good news but an increase in female representation is especially valuable because of the undeniable benefits of diversity.

Also speaking at the launch were Geoff Prince, Director of AMSI, Senator Scott Ryan, Parliamentary Secretary to the Minister for Education and Training, who significantly encouraged us not to use acronyms like STEM (science, technology, engineering and maths) in discussions with the general public, and Lily Serna, a member of the AMSI Board and former host of the SBS program Letters and Numbers.

While AMSI has long been concerned with the issues of secondary mathematics education, it is also keen to promote research. Geoff outlines some plans to realise the vision of a National Research Centre in the AMSI report.

Tim Marchant discusses some other international research collaborations in the President's column, along with the perennial issue of funding for education and research.

It remains our sad duty to note the passing of Australian mathematicians. This issue contains obituaries of Gordon Preston and Ken Smith, while the News section records the deaths of Emanuel Strzelecki and Ken Pearson.

Five book reviews appear in these pages, possibly a record for us. We are indebted to all reviewers, in this and previous issues, for their time and effort in preparing them.

As always, our other regular features include the Puzzle Corner and news from the AustMS. We hope that all this provides some interesting reading.

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

President's Column

Tim Marchant*

Most members will be aware of the continuing push by the Federal Government to deregulate university tuition fees for domestic students and the blocking of these measures in the Australian Senate. This policy stalemate is causing great uncertainty in the university sector with adverse consequences for teaching and research in the Mathematical Sciences. Many universities have implemented hiring freezes or cutbacks and programs such as the National Collaborative Research Infrastructure Strategy (NCRIS) and the ARC Future Fellows (FT) are threatened. Recently NCRIS has received a year's funding reprieve but the fate of the FT scheme is unknown. The FT scheme supports mid-career researchers by funding them for four years of research intensive activity. In the six years the FT scheme has been operational about fifty mathematicians have been awarded Future Fellowships and the scheme has been vital in supporting the careers of some of our most promising members. Hence I believe that it critical that the FT scheme continues and that a bipartisan approach is needed, from our politicians, in developing a sustainable and appropriate funding model for our university sector.

International research and teaching collaborations are very important to Australia for many diverse reasons, such as research visibility, international student commencements and engagement with the growing economies of Asia. Hence I was pleased to attend the recent launch of the LaTrobe University branch of the Kyushu University Institute of Mathematics for Industry. This partnership between LaTrobe and Kyushu University, located in the south of Japan, provides a great opportunity for Australian mathematicians to engage with one of the strongest industrial economies in Asia and home to many of the world's leading high technology companies. The Institute will make joint academic appointments, who will work both at Latrobe and Kyushu Universities.

The Australia-Germany Research Cooperation Scheme has recently been launched by Universities Australia (UA) and the German Academic Exchange Service (DAAD). The scheme will support the travel costs for joint research projects between academics based at Australian and German universities. As such the scheme is highly suitable for mathematicians as funding for visits is often the key ingredient to facilitating our joint research activities. Previously, the G8 and ATN universities had links with DAAD but now nearly all Australian university-based researchers can participate. DAAD is committing one million Euros per annum to the program, which is being matched by $1.4 million dollars from Australian universities.

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As part of a campaign to boost AustMS membership I will soon be writing to all academics who are employed in Australian mathematics departments, but who are not Society members. I will detail the benefits of membership and encourage them to join the Society and I ask current members to reinforce these messages, in their discussions with new appointments in their workplaces.

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

Puzzle Corner

Ivan Guo*

Welcome to the Australian Mathematical Society *Gazette*'s Puzzle Corner number 42. Each puzzle corner includes a handful of fun, yet intriguing, puzzles for adventurous readers to try. They cover a range of difficulties, come from a variety of topics, and require a minimum of mathematical prerequisites for their solution. Should you happen to be ingenious enough to solve one of them, then you should send your solution to us.

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

The deadline for submission of solutions for Puzzle Corner 42 is 15 July 2015. The solutions to Puzzle Corner 42 will appear in Puzzle Corner 44 in the September 2015 issue of the *Gazette*.

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

Volume valuation

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

Random subsets

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

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Musical musing

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

Repeated rummage

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

Suitable suitor

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

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

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

Solutions to Puzzle Corner 40

Many thanks to everyone who submitted. The $50 book voucher for the best submission to Puzzle Corner 40 is awarded to Jensen Lai. Congratulations!

Rolling riddle

On average, how many times do you have to roll a die before all six numbers appear at least once?

Solution by Steve Clarke: The answer is 14.7. If $k < 6$ of the numbers have already appeared, the chance of rolling a new number is $\frac{6-k}{6}$. Using the standard result for geometric distributions, the expected number of attempts before we get a new number is $\frac{6}{6-k}$.

Therefore the expected number of rolls to obtain all 6 numbers is given by

$$\frac{6}{6} + \frac{6}{5} + \frac{6}{4} + \frac{6}{3} + \frac{6}{2} + \frac{6}{1} = 14.7.$$

Balanced views

Given a convex polygon $A_1A_2\cdots A_n$ *in the plane, we say a point* P *(in the same plane) is* balanced *if*

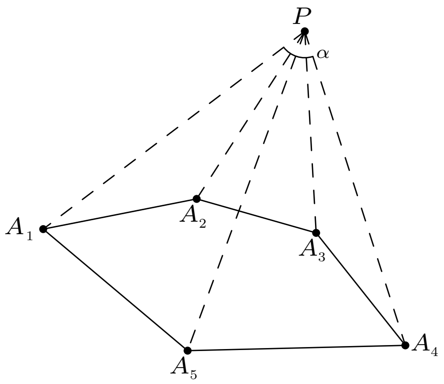
$$\angle A_1PA_2 = \angle A_2PA_3 = \cdots = \angle A_{n-1}PA_n = \angle A_nPA_1.$$

(i) *Prove that for any convex polygon with an odd number of sides, there is at most one balanced point in the plane.*

(ii) *Can there ever be more than one balanced point if the convex polygon has an even number of sides?*

Solution by Jensen Lai: (i) A balanced point P cannot coincide with a vertex of the polygon, as then some of the angles will be undefined. Furthermore, a balanced point P cannot lie on an edge of the polygon, otherwise all relevant angles have to be 180° and the convex polygon degenerates into a straight line. So we have ruled out the possibility of P lying on the perimeter of the polygon.

Begin with a convex polygon $A_1A_2\cdots A_n$ where n is odd. Suppose there exists a balanced point P outside of the polygon. Consider the convex hull of $A_1, A_2, \ldots, A_n$ and P. Let the angle of the convex hull at P be α, as shown in the following diagram.



By the definition of balanced points, we must have

$$\theta = \angle A_1PA_2 = \angle A_2PA_3 = \cdots = \angle A_{n-1}PA_n = \angle A_nPA_1. \tag{1}$$

The angle θ cannot be 0°, otherwise all points must be collinear and the polygon is degenerate. Since P is outside of the original polygon, some of the angles in (1) are oriented clockwise while others are oriented anticlockwise. Let the number of clockwise angles be p and the number of anticlockwise angles be q, where $p + q = n$. If we sum up the clockwise and the anticlockwise angles separately from each other, we must have

$$\alpha = p\theta = q\theta \quad \Longrightarrow \quad p = q.$$

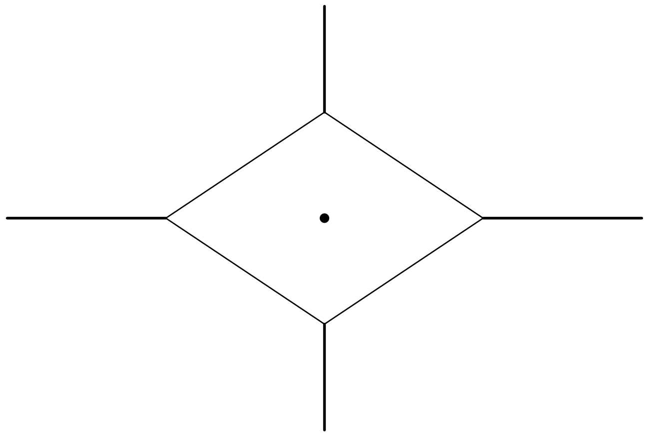
This is a contradiction since $n = p + q$ is odd.

It suffices to show that there is at most one balanced point inside the polygon. For any balanced point P, all angles in (1) must be oriented in the same direction (e.g. clockwise). Hence $\theta = \frac{360^\circ}{n}$. If there is a second balanced point Q distinct from P, we must have

$$\angle A_1PA_2 = \angle A_1QA_2 = \frac{360^\circ}{n}.$$

This implies that A_1PQA_2 is a cyclic quadrilateral. By the same argument A_2PQA_3 is also a cyclic quadrilateral. Since a circle is defined by three points, all five points A_1, A_2, A_3, P and Q must all lie on the same circle. Repeating the argument for $A_4, A_5, \ldots$, we see that the points $A_1, A_2, \ldots, A_n, P$ and Q all lie on a single circle. This is a contradiction since P and Q lie inside the convex polygon $A_1A_2\cdots A_n$. Therefore there can be at most one balanced point.

(ii) In the case of n being even, the proof in part (i) also shows that there can be at most one internal balanced point. However, there may be multiple external balanced points. For example, in the case of a rhombus, the centre as well as all points on the extensions of the diagonals are balanced points.



Spherical stroll

An ant is crawling on the surface of a sphere whose radius is one metre. After a while, the ant returns to its starting position. Prove that if the ant has crawled no more than 2π metres, then its path can be contained in some hemisphere of the sphere.

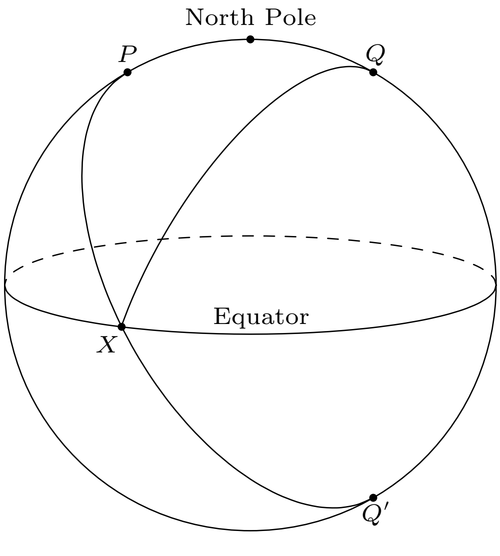
Solution: For any two points A and B on the surface of the sphere, denote by AB the shortest path between A and B along the surface. If A and B are antipodal points, there are multiple shortest paths, each in the shape of a semicircle. In this case, the usage of AB will avoided.

It suffices to assume that the ant has crawled exactly 2π metres, as it can always take additional round trips to make up the distance. Let the starting point be P and let the 'halfway point' (when the ant has crawled exactly π metres) be Q. If P and Q are antipodal points, then the shortest distance between P and Q is exactly π metres. This means that the ant's journey consists of two semicircles between P and Q. It is clear that we can choose a hemisphere which contains both semicircles.

Now suppose P and Q are not antipodal points. Without loss of generality, let the midpoint of PQ be the north pole. We shall prove that the ant's journey is contained in the northern hemisphere.

For the sake of contradiction, assume that the ant leaves the northern hemisphere during the journey $P \to Q$. This means it must cross the equator at some point, say X. In particular, the ant travels a total of π metres in the journey $P \to X \to Q$. Let us reflect the second half of this journey, $X \to Q$, about the equator to obtain the journey $X \to Q'$. Thus Q' is the reflection of Q and the journey $P \to X \to Q'$ is also π metres long.

Recall that the midpoint of PQ is the north pole, this implies that P and Q' are antipodal points. Since the shortest distance between P and Q' is π metres, the journey $P \to X \to Q'$ must be a semicircular path consists of PX and XQ'. This means that the original journey $P \to X \to Q$ must consist of the shortest paths PX and XQ. But both PX and XQ are still contained in the north hemisphere. This is a contradiction and the solution is complete.



Digital division

Consider the set of all five-digit numbers whose decimal representation is a permutation of digits 1, 2, 3, 4 and 5. Is it possible to divide this set into two groups, so that the sum of the squares of the numbers in each group is the same?

Solution by Joe Kupka: Yes it is possible. Consider the permutations which start with 12 and divide them into two sets:

$$G = \{12345, 12453, 12534\}, \qquad H = \{12354, 12543, 12435\}.$$

It is clear that $\sum_{n\in G} n = \sum_{n\in H} n$. Using this fact, we have the following sequence of equalities:

$$\begin{aligned}\sum_{n\in G} n^2 - (66666-n)^2 &= \sum_{n\in G} 66666(2n - 66666)\\ &= \sum_{n\in H} 66666(2n-66666)\\ &= \sum_{n\in H} n^2 - (66666-n)^2\end{aligned}$$

Rearranging gives us

$$\sum_{n\in G} n^2 + \sum_{n\in H}(66666-n)^2 = \sum_{n\in H} n^2 + \sum_{n\in G}(66666-n)^2. \tag{2}$$

When n is a five-digit permutation starting with 12, the number $66666 - n$ is a five-digit permutation starting with 54. Thus equation (2) has taken all five-digit permutations starting with either 12 or 54, and divided them into two sets with equal sums of squares.

We can repeat this argument for any two starting digits. Denote by S_{ab} the set of the numbers with ab as the first two digits. There are 20 such sets, each with 6 numbers. Since the digit strings ab and $(6-a)(6-b)$ are always distinct, we may pair up S_{ab} with $S_{(6-a)(6-b)}$ to from 10 groups of 12 numbers. Using (2), each group can be divided into two sets with equal sums of squares. Combining them gives the desired result.

Note: As evident from the solution, there is a lot of flexibility in how the numbers can be divided. Another neat idea is to divide them based on their permutation parity.

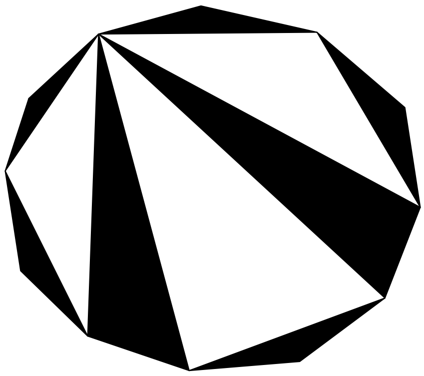
Tricky triangulation

For $n \geq 3$, a convex n-gon can be divided into $n-2$ triangles by using $n-3$ of its diagonals. This is called a triangulation. *For which values of n is it possible to triangulate a convex n-gon such that every vertex is adjacent to an odd number of the resulting triangles?*

Solution by Jensen Lai: Such a triangulation is possible if and only if n is a multiple of 3.

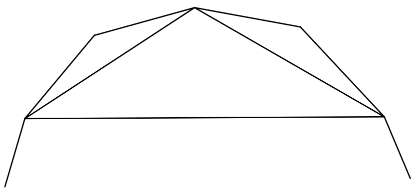
Consider an n-gon with a valid triangulation. Colour the triangles in the following way. First, select a triangle touching the perimeter of the n-gon and colour it black. Then, use white to colour all triangles sharing an edge with the black triangle. Then, use black again to colour all triangles sharing an edge with any of these white triangles. Continue to colour the triangles in this fashion until all $n-2$ triangles have been coloured.

Since all triangles are formed by diagonals and sides of the n-gon, there can be no conflicts in colouring as there is only one path to each triangle from the original black triangle. Furthermore, we note that no two triangles of the same colour share an edge and every diagonal borders a black triangle and a white triangle.



Since each vertex of the n-gon is adjacent to an odd number of triangles, the two triangles touching the perimeter of the n-gon must have the same colour. Hence, just like the starting black triangle, all triangles touching the perimeter must be black. In other words, every white triangle is formed by three diagonals. If the number of white triangles is w, there must be $3w$ diagonals. Since there are exactly $n-3$ diagonals, n must be a multiple of 3.

It remains to construct a valid triangulation whenever n is a multiple of 3. This can be done inductively. The base case of $n = 3$ is trivial. Given an existing valid n-gon triangulation, a valid $(n+3)$-gon triangulation can be formed by attaching the following structure to an existing side.



Ivan is a Postdoctoral Research Fellow in the School of Mathematics and Applied Statistics at The University of Wollongong. His current 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.

Vale Gordon Preston

28 April 1925 to 14 April 2015

(Photograph courtesy of School of Mathematical Sciences, Monash University)

The mathematical community mourns the death of Emeritus Professor Gordon Preston who passed away peacefully on 14 April 2015 in Oxford, UK at age 89. Professor Preston was an important contributor to algebraic semigroup theory, one of the founding professors of the School of Mathematical Sciences at Monash University and a respected head of school during his numerous appointments from 1963 until his retirement in 1990.

Gordon Preston was born 28 April 1925 and grew up in Carlisle, UK. He began his higher education in 1943 when he received a scholarship to the University of Oxford. He would ultimately graduate with first class honours in mathematics, but Preston's studies were interrupted when he was called up for war service towards the end of World War II. Even early on in his mathematical career, Preston's talents were recognised and he was drafted to work at Bletchley Park. It was here that he received his first taste of research, joining the 'Newmanry' — a small group of approximately 20 mathematicians lead by Max Newman.

During his time at the Newmanry, he got to know and to work with other brilliant mathematicians: he recalled spending numerous hours playing Go with the famous code-breakers Alan Turing and David Rees. His time at Bletchley Park

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This obituary was originally published in the *Monash Memo*.

Some of the information for this obituary was taken from the following source:

Preston, G.B. (1991). Personal reminiscences of the early history of semigroups. In *Monash Conference on Semigroup Theory, Melbourne, 1990.* World Scientific Publishing, River Edge, NJ, pp 16–30.

and relationship with David Rees was instrumental in his desire to study semigroup theory: Rees authored the first paper Preston read on the topic.

Upon graduating, Preston was appointed as an Assistant Mathematics Master at the prestigious Westminster School in London. He would leave this position to continue teaching at the Royal Military College of Science. Preston did not abandon research however, and worked part-time on his Doctorate of Philosophy, completing his thesis in 1954: *Some Problems in the Theory of Ideals*.

The Cold War tensions did not deter Preston's quest for knowledge: he insisted on reading an important paper published in the early 1950s by a renowned Russian mathematician. The fact that he did not understand the Russian language nor alphabet was merely a small setback — he equipped himself with a Russian dictionary and spent three hours translating the first sentence alone!

Perhaps Preston's most important contribution to semigroup theory was a set of standardised definitions and terminology. Although the theory was first discussed in 1904, mathematicians would disagree on definitions for the next 50 years (and without standardised definitions it was incredibly difficult to apply a theorem to new situations). So in the 1960s, Preston and his colleague Alfred Clifford set out to standardise semigroup definitions in a monograph that would unite the field and act as a reference for a generation of semigroup-ers: *The Algebraic Theory of Semigroups*, published in two volumes in 1961 and 1967.

Preston left the UK and migrated to Australia in 1963 where he took the position Chair of Mathematics at Monash University. During his career, he published several important papers, opting for quality over quantity. In academic genealogy, Preston had at least 8 students and over 56 descendants. His legacy remains very much present, with three of his former students still at Monash — Dr Phillip Edwards, Dr Thomas Hall and Dr Ross Wilkinson. We even owe some of the contemporary design features of the Mathematical Sciences building to Preston's innovative ideas.

He is remembered through a number of student awards including the Gordon Preston Pure Mathematics Honours Scholarship and the annual Pure Mathematics Prize at Monash University as well as the Victorian Algebra Conference's Gordon Preston Prize.

Anna Haley
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Obituary: Kenneth Graham Smith

Australian mathematics has lost one of its most valuable members with the death of Dr Ken Smith on the 4th of March in Brisbane. Ken completed a BSc with first class honours in mathematics at Sydney University in 1954. He continued with an MSc in 1955 and later graduated with a PhD at the University of Queensland in 1975. He held positions as a Senior Scientific Officer at the Royal Aircraft Establishment, Bedford, where he worked on the Concorde, from 1961 to 1965 and was recruited by Professor Fenton Pillow in 1965 who supervised his PhD entitled 'Unsteady viscous axisymmetric flows associated with rotating surfaces'. He retired as a senior lecturer at the University of Queensland in 1997.

His interests were widespread; his knowledge of the literature comprehensive; his research publications addressed compressible flow. He lectured at all levels in applied mathematics, including fluid dynamics and operations research; he helped to introduce the teaching of operations research at UQ. His lecture notes were highly regarded by students and colleagues as concise, accurate, accounts of their subject matter.

Ken's commitment to the mathematics community was complete; timetabling, academic advising, and as the local guru with TeX. His templates are still used for the setting up of examination papers in mathematics at UQ.

He was a devout Baptist Christian, he continued in Counselling Services at the University of Queensland until 2012. He is survived by his wife Helen and six children, thirteen grandchildren and three great-grandchildren.

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Book Reviews

Origami^5

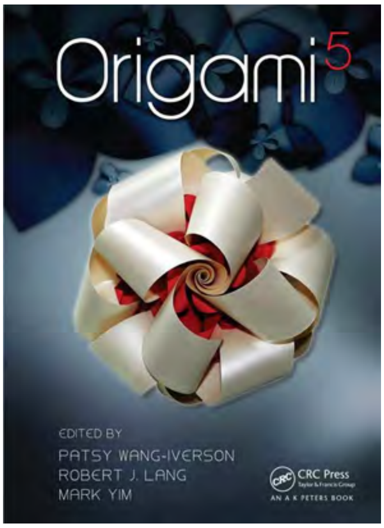
Patsy Wang-Iverson, Robert J. Lang and Mark Yim, Editors
CRC Press, Boca Raton, FL, 2011, ISBN 978-1568817149

Introduction

This fine volume — in my opinion a cornucopia of good things — is the proceedings of the 'Fifth International Meeting of Origami Science, Mathematics, and Education' although as opposed to most conference proceedings, much of this material is accessible to the general reader. There is in fact a fourth section (which is first in the volume), not listed in the subtitle, on 'Origami History, Art, and Design'.

There are too many delights in this volume to discuss each one at length; so I will discuss some sample chapters from each section, and finish with some general remarks.

1. Origami History, Art, and Design



The first chapter, 'History of Origami in the East and West before Interfusion', by Koshiro Hatori, starts off by vigorously refuting the common belief that origami originated in China. There appears to be no evidence to support this; however, origami developed independently in both Japan and the West. Japanese folds used paper with different shapes, as well as cuts, and the results were often painted. Western folding was stricter, using mostly square or rectangular paper, and no cuts. Japanese folds, often as wrappers for gifts, were embedded in the samurai tradition; Western folding had its antecedents in the folding of baptismal certificates. What we now understand as 'origami' is a remarkable fusion of both the Japanese and Western forms.

A paper with the interesting title 'Simulation of Nonzero Gaussian Curvature in Origami by Curved-Crease Couplets', is not fully of heady mathematics, but more of a description of how curved surfaces can be generated by a sort of pleating technique. A 'curved-crease couplet' consists of two consecutive folds, one a mountain (or ridge); the other a valley, where one fold is straight and the other curved. Many pictures illustrate the richness of this approach to producing three dimensional curved figures; there is a brief digression on ruled surfaces.

Another paper looks at the extraordinary curved-crease sculptures of David Huffman, who you might know as being the inventor of Huffman codes. This section finishes off with a paper about 'oribotics' (a fusion of origami and robotics), and discusses a sort of folded flower which opens and closes depending on the amount of light falling on it. Some of this chapter is devoted to discussing the material which is used here: as well as paper, the creator has used polyester which is 'cooked' in a steam oven to stabilize its folds.

2. Origami in Education

Origami as an educational tool has a long history in Japan, and in primary schools in the west. There seems to be a growing interest in using origami as an educational tool in secondary and post-secondary education; one article has the enticing title 'Origami and Spatial Thinking in College-Age Students', and reports on the use of origami as part of general studies program at an American tertiary college. The article, however, spends most of the time discussing Likert scales, the use of ANCOVA to measure the different scores between groups of students, and is short on particulars: what the students actually *did*, and what they were expected to learn. The author's conclusion was that students did indeed increase their spatial reasoning skills, but also warns carefully that not all of this increase is necessarily attributable to the use of origami.

An article 'My Favorite Origamics Lessons on the Volume of Solids' (here 'origamics' means 'the mathematics of origami') pulls together origami, Cauchy's mean value theorem, and various elementary optimization problems — the sort of 'word problems' which have been trotted out for ever to first-year students. It may well be that some ideas in this article could be used to great effect to aid three-dimensional thinking. I don't know about *you*, but many of *my* students have a great deal of difficulty moving between the description of an object and its abstract representation.

However, my favorite article in this section is 'Narratives of Success: Teaching Origami in Low-Income Urban Communities', which reports on the use of origami in a Chicago school, the student body of which was predominantly African-American and Hispanic, most students having poor literacy and numeracy skills as well as learning difficulties. 'For the girls, that often meant they had been pregnant . . . , and/or had spent time in jail. For the boys, it usually meant they had been in jail and/or had an unstable home life or no home at all.' The author describes helping the children first make origami models and then write stories about them, and how the combination led to real learning from the first time. Note that the students here had a true poverty of learning: the idea that paper could be used to fold shapes and animals or flowers was completely new to them: '. . . I did home visits where the only visible thing in the house was a crack pipe or a stained mattress'. Anybody who doubts the transformative power of education would do well to read this article.

3. Origami Science, Engineering, and Technology

You would expect that origami would have many applications in the sciences and engineering, which indeed it does, and engineers are beginning to sit up and take notice. Thus in 'The Origami Crash Box' the authors explore, using amongst other tools finite element methods, how to create a crumple zone, such as in car, which would absorb most of the force in a crash while leaving the occupants unhurt. Such modelling and construction is now fundamental to car manufacture, and this article investigates how origami modelling techniques can be used in the design of such crash boxes.

Another article: 'Origami Folding: A Structural Engineering Approach' looks at the structural properties of sheets folded into a textured pattern. The bending properties, stiffness, rigidity and strength of such sheets is shown to have many applications, from lighter and stronger cardboard, to sheets which must undergo deformations, such as the skin of aircraft wings. This article is mostly discursive, with only minimal mathematics, but I don't think that detracts from its interest.

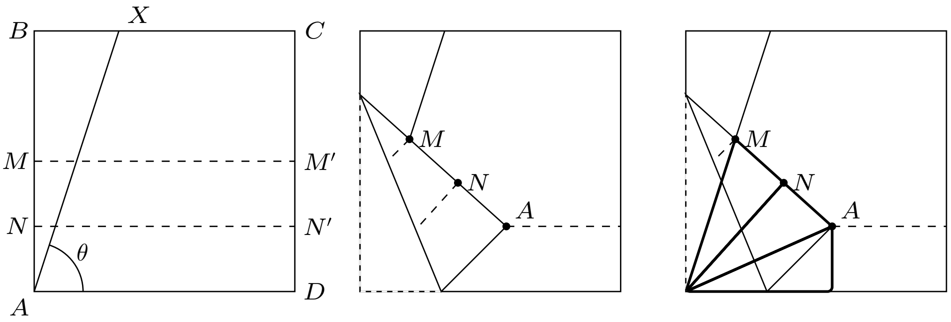
4. Mathematics of Origami

Here is where it gets most interesting, at least for the readers of *this* review. But before I launch into a discussion of the articles, some background. Much of the mathematics of origami has in antecedents in a set of axioms developed by the French mathematician Jacques Justin (who seems to have been the first to enumerate them in full), the Italian-Japanese mathematician Humiaki Huzita, and more recently still by Koshiro Hatori. The axioms are referred to by any non-empty subset of Huzita–Hatori–Justin. These axioms enumerate precisely the folds which are possible, and the first few are pretty much what you'd expect: a point can be folded onto another point, two points can be joined by a fold which passes through them both, a crease can be folded onto another crease, and so on. Note that the axioms only concern straight folds. With these axioms it is possible to construct all points constructible by (unmarked) ruler and (collapsible) compass. However, there is one axiom which describes a construction which has no Euclidean equivalent:

> Given two points p_1 and p_2, and two lines L_1 and L_2, there is a fold which places p_1 on L_1 and p_2 on L_2.

It can be easily shown that the construction of this fold is algebraically equivalent to solving a quartic equation; hence with origami constructions it is possible to trisect any angle, or construct irrational cube roots.

For example, Figure 1 shows one construction for trisecting an angle.



(a) Initial folds

(b) Fold to find points of trisection

(c) Proof that the construction works

Figure 1: Trisecting an angle

Start with a square $ABCD$; the angle XAD is to be trisected. Crease the paper in half along MM' and fold the bottom edge AD to MM' and out again, making a crease one-quarter up the paper through NN'. Now fold the bottom left corner in such a way that point M lands on line AX and A lands on line NN'. Then the lines from the new positions of A and N to the bottom left will trisect the angle. The right-most diagram shows why this construction works; all the triangles are the same.

A clever construction of $\sqrt[3]{2}$ is similar and is shown in Figure 2: start with a square creased into vertical thirds. Fold the bottom left corner to the top edge in such a way that the left vertical crease lies on the right vertical crease.

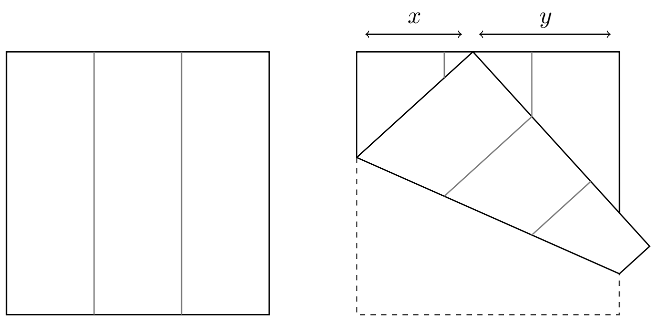


Figure 2: Origami cube root

Then the position of the corner along the top edge divides that edge into a ratio of $y/x = \sqrt[3]{2}$.

These folds are equivalent to the Greek *neusis* construction, which uses a marked ruler: that is, a ruler with two marks on it; and with which it is also possible to trisect angles and construct irrational cube roots.

There are many different lines of origami research; one explores the concept of a 'multifold' where several folds are made simultaneously so that various edges and points line up. Although a double fold is just possible with fiddling, higher degree multifolds would seem to severely stretch the bounds of practical folding. However, by using multifolds it can be shown that higher degree polynomial equations are solvable. Another direction of generalizing is multidimensional origami, where instead of folding a plane along a line, one folds a 3-space along a plane. This must of course remain purely theoretical, and yet you'd expect some fascinating geometry.

This section is the longest. The first article: 'An Introduction to Tape Knots' is by Jun Maekawa, who is known for some fundamental theorems about crease patterns. Tape knots are obtained by knotting up strips of paper: that a pentagon can be made from an overhand knot is well known. The article first explores polygons of odd and even sides, and then looks at the structures of the knots themselves, with some crossing diagrams. It would be fascinating to know if the polygonal nature of the final knot has any relation with some of the standard knot invariants. The paper also mentions links, along with some crossing diagrams.

Erik Demaine from MIT is the coauthor of several papers, one of which is a small, neat paper 'Folding Any Orthogonal Maze' which describes precisely that: an algorithm for folding a maze out of paper, using what Demaine calls 'gadgets'; for example parts of the maze corresponding to a single wall, a corner where two walls meet. Although there is no proof, the paper makes the claim that the algorithm is optimal in the sense of requiring the smallest grid for the maze.

Roger Alperin, well known for his research into the mathematics of origami, is represented here by 'Origami Alignments and Constructions in the Hyperbolic Plane', using for the purpose the Cayley–Klein model, where the plane is a disk, and lines on the plane correspond to lines on the disk. The article introduces six basic constructions, and shows that these can be used to construct all points in the hyperbolic plane which could be constructed with compass and marked ruler. As mentioned above, in the Euclidean plane such constructions are called *neusis* constructions; it is known that classical origami and neusis constructions are equivalent in the sense of producing the same set of constructible points. Alperin shows here that this result is also true in the hyperbolic plane.

This section ends with what is, to me, a very elegant high point: 'Circle Packing for Origami Design is Hard', by Erik Demaine, Sándor Fekete, and Robert Lang. This paper considers the problem of packing circles into a square: such packings are the first step in generating a 'crease pattern' for the creation of a model with lots of points, such as an insect. The centres of the circles will become the points such as legs, antennae, wings. This paper proves that finding an optimal packing is NP-hard. Such problems form a superset of NP-complete problems, and may be considered to be at least as hard as any of them. The authors briefly discuss approaches to minimizing the size of paper required to contain a given set of circles; this research is ongoing.

Final remarks

Most of the mathematics in the book, especially in the first three sections, tends to be discursive and general; this is to be expected of a conference which is only in part mathematical. You should not be misled by this into thinking that the mathematics of origami is trivial or shallow; origami research is increasingly calling on more and more branches of mathematics, with published articles referencing Galois Theory, combinatorial, algebraic and differential geometry, Gröbner bases and much else.

This volume is thus a fascinating snapshot into the current world of origami research, and of the many applications in which the theory and practice of origami are leading to new insights.

A minor complaint is that the relatively low printing resolution has meant that the fine detail in some diagrams — and most photos — is obscured or blurred. In such a diagram-rich discipline as origami, precision of diagrams is not just a luxury but a necessity. To some extent this is ameliorated by a handsome inclusion of colour plates, but even so I wish that some diagrams had been re-drawn for greater clarity.

A very nice touch is the inclusion of an index.

I think every academic library should have a copy — at least electronically. Whether you are a research mathematician, a mathematics educator, whether you are a professional or an interested amateur, whether you are in a research hiatus and looking for a project, or whether you are looking for a project for your students, you could do much worse than investigate this volume. You may find material which sparks an idea. And even if not, you will have been exposed to some elegant and delightful mathematics.

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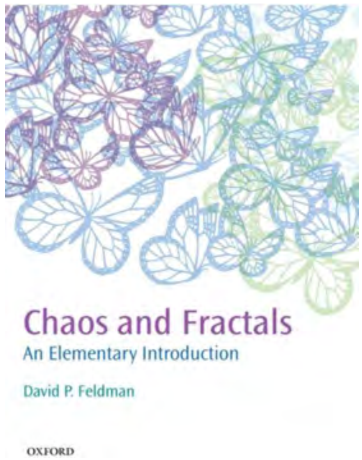
Chaos and Fractals: An Elementary Introduction

David P. Feldman
Oxford University Press, 2012, ISBN 978-0-19-956643-3

They say not to judge a book by its cover, but if one can't do that, then one can judge it by the format of its content. On that basis this book obtains top marks. Each page has only one column of text that is about two-thirds the width of the page, so there is good deal of white space. In that column of white space the author has on some occasions footnotes, or captions for a figure that is in the main text column. Also at the start of each chapter is the section headings for the chapter, with their pages numbers, listed in that one-third column. So the presentation of this book is one of clarity and an invitation to come read. An important aspect for any book, but certainly more so for a text book, which is essentially what this book is. I was impressed with its layout and presentation, which of course puts the reader in a positive frame of mind when tackling the guts of the matter, that is the text. So top marks from me on that aspect.

Also there are exercises at the end of each chapter, but unfortunately no answers, not even for selected exercises, which was somewhat disappointing. Some of the exercises mirror closely the worked examples in the body of the text and some lead onto other concepts in the next chapter. All round a thoughtful approach, despite there being no answers. However there is more. At the end of some chapters there is a section titled 'Further Reading', with the first appearance being in chapter zero and the next not until chapter seven. Still another nice touch that is eminently helpful both for student and casual reader like myself.



The book is divided into seven sections that are in order: 'Introduction to Discrete Dynamical Systems', 'Chaos', 'Fractals', 'Julia Sets and the Mandelbrot Set', 'Higher-Dimensional Systems', a 'Conclusion' along with the ubiquitous 'Appendices'. As can be seen the core of the matter is sections two through to five. The first section, 'Introduction to Discrete Dynamical Systems', is the only odd one out in that its material is pretty basic and most chapters would have been familiar to, or at least taught to a student in the first years of high school. For example the first chapter covers different ways of viewing a function; as a formula; as a graph; as a map and so forth. The second chapter covers iterating a function. So all of this would bore a tertiary student pretty quickly, which is a pity because the core material is a treat. Interestingly, in the preface the author notes that students have reported the slow start to the book due to the eight chapters of section one being in the way of the core material. It would be easy to include seven of those chapters in the Appendices as revision material for the student who needed to do that. Otherwise I fear he would lose some students before they arrive at the meat of the book.

The sections from ‘Chaos’ to ‘Higher-Dimensional Systems’ are well set out, clear and amply illustrated with graphs that are worth a thousand words. Mr Feldman covers aperiodic behaviour; the sensitivity of initial conditions; the bifurcation diagram plots histograms of chaotic orbits; chaotic systems being sources of randomness; the dimensions of fractals using the favourites such as snowflakes, Cantor sets, Sierpinski triangle; as well as random fractals. So as can been seen from that small sample in just the areas of Fractals and Chaos, all the major areas are covered, along with suggested reading if one wishes to extend their knowledge. Similarly for the Julia Sets, Mandelbrot Sets, Discrete Dynamical Systems, Lorenz Attractors and One-dimensional Cellular Automata, there are clear explanations of them all along with many graphs and exercises to keep the student or intrigued recreational mathematician enthralled. There is much more besides the brief examples I have given above. All that I can do is give you an indication of the breadth of material in this book. The rest is up to you.

The book isn’t without some typos but they are reasonably obvious and don’t detract from the overall value and impact of the book. A nice surprise was the mention on a couple occasions in the book of Michael Barnsley’s work with Fractals. I enjoyed an interesting Fractal talk of Michael’s at a recent EViMS Conference at ANU. It was a good prelude to reviewing this book.

There is an Appendix chapter devoted to further reading that covers a selection of books from a popular style to more advanced texts, as well as a few online resources. These are of course a very brief selection and if your thirst has been whetted then there is an impressive References section to troll through. All this is rounded out with a short index. So for any lecturer or teacher looking for a text on these subjects, this book is worthy of your consideration. For the student or layperson interested in these subjects it is a good read and could be read without completing the exercises. However, you would miss out on half the fun, these subjects just begged to be played with. If you haven’t guessed already I recommend this book.

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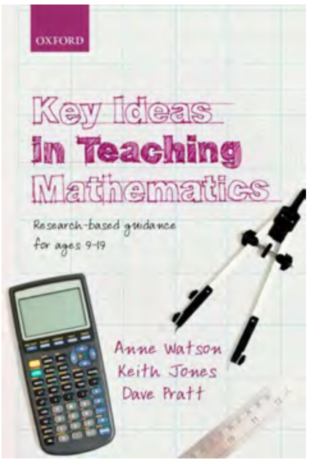
Key Ideas in Teaching Mathematics: Research-based guidance for ages 9–19

Anne Watson, Keith Jones and Dave Pratt
Oxford University Press, 2013, ISBN 978-0199665518

A few opening remarks

Most academic mathematicians are involved in some teaching, and up until recently few, if any, had any formal educational qualifications. This means that most tertiary mathematics educators have little grounding in educational theory, or of current research and practice in mathematics education. Such teachers tend to teach either the way they were taught themselves, or a method they have evolved which works for them. An immediate result is the preponderance of ‘chalk and talk’ in lectures, and ‘drill and practice’ in tutorials. As well there are constant complaints about the poor standard of students ‘nowadays’: they can’t do algebra, they don’t know how logarithms work, they don’t seem to be able to understand how a function and its graph are related. Come on, own up — when was the last time you complained about the ill-preparedness of your first year students?



It seems to me that anybody who teaches mathematics at any level owes it to themselves and their students to have a basic working knowledge of educational theory, and in particular as it relates to the teaching of mathematics. Tertiary teachers should also have some understanding of school curricula and school teaching: what are secondary students being taught, and how are they learning it?

This book is timely, and has the enormous advantage of being written clearly and simply. The authors have eschewed jargon for clarity — a very sensible decision which I wish more education authors would emulate. In Australia, as elsewhere, tertiary mathematics educators are struggling with heavy workloads, competing demands of research and administration, and an increased internationalization of the student cohort. This makes it all the more necessary that such teachers look at how and why students learn the way they do, and learn why students have their difficulties.

Although this book may appear, from its title, to have little interest for the practising tertiary mathematics educator, nothing could be further from the truth. This book should be essential reading for all.

The book and its contents

This book grew out of a study funded by the Nuffield Foundation in 2008 into how children aged 6–16 learn mathematics. This book is a synthesis of that research, and embodies a learner-centred paradigm: "We have viewed mathematics as developing 'bottom-up' through learning rather than solely 'top-down' from an academic viewpoint." There are seven 'domains' about which the book is structured, with one chapter for each: relations between quantities and algebraic expressions; ratio and proportional reasoning; connecting measurement and decimals; spatial and geometrical reasoning; reasoning about data; reasoning about uncertainty; functional relations between variables. A final chapter looks at moving beyond basic mathematics to more advanced material such as may be developed further at a post-secondary level.

The book contains numerous QR codes by which the reader can immediately be taken to an online resource at the nuffieldfoundation.org site. This is quite a good idea; it's hard to think of an easier way of moving between printed and online material.

In the first 'domain' chapter, 'Relations between quantities and algebraic expressions', there is a long discussion about the many ways in which notation is confusing: for students in early years, the concept of using a 'letter' instead of a 'number' can give rise to many difficulties. The list of misconceptions of algebraic notation include:

- treat letters as shorthand, for example $a =$ apple;
- some students believe that different letters have to have different values, so would not accept $x = y = 1$ as a solution to $3x + 5y = 8$;
- different symbolic rules apply in algebra and arithmetic, for example '2 lots of x' is written '$2x$' but 'two lots of 7' are not written '27'.

These misconceptions, if left unnoticed or not managed in a timely fashion, can seriously impact a student's learning of more mathematics. The authors describe some of the research into the teaching and learning of algebra and note that there is no 'best sequence' for teaching algebra. They approvingly note the usefulness of computer algebra systems (mentioning Mathematica, Maple), and with regard to drill and practice, quote a researcher who comments on the notion that this is always a Good Thing: 'if the students spend enough time practicing dull, meaningless, incomprehensible little rituals… something WONDERFUL will happen'. This is not to say that drill and practice doesn't have its place, but the exercises must be carefully chosen so that the notions become fully internalized ('such as happens with reading, writing, learning dance steps, and so on'), in which case 'something wonderful *can* happen'. This chapter also includes various possible approaches for teaching algebra, along with some comments about the advantages and limitations of each approach.

The next chapter, on ratio and proportional reasoning, points out that these concepts are extremely difficult, mainly because of the many ways they are used. The concept 'fraction' can be simply defined in a number of ways, but as is so often the case a formal definition is no help for elementary teaching. It may seem that fractions are trivial, but even in post-secondary classes we find students who seem to have difficulties with the conceptual handling of fractions — let alone the algebra associated with them! The authors claim that students need to be exposed early and often to the many uses and meanings associated with fractions and ratios: 'This is the strongest recommendation to emerge from this chapter: the need to provide students with repeated and varied experiences, over time, so that multiple occurrences of the words and the associated ideas and methods can be met, used, and connected.' The authors note that this topic is hard, partly because much of it depends on dealing with the equality of two fractions: $a/b = c/d$; the fractions perhaps being expressed as ratios. Students have to decide what to multiply, or divide, and by how much, and in 'mixing problems' (mixing orange juice and water, for example), they can't reduce the problem to counting.

'Connecting measurement and decimals' sounds like kindergarten material — when was the last time you talked seriously about 'decimals'? And yet even supposedly well-educated adults have difficulty here. Recent research has uncovered some extraordinary gaps in understanding, such as people believing that, for example, 0.13 was bigger than 0.7 because '13 is bigger than 7'. Apparently simple notions such as place value can be daunting, and require careful and precise teaching. Measurement is inextricably linked with counting, and here we have other difficulties such as students attempting to find the area of a rectangle by adding the length of its sides. The authors call for a stronger link between measurement and decimals at the secondary school level.

'Spatial and geometric reasoning' points out that such reasoning can be powerful because of its intuitive nature, and quote Sir Michael Atiyah saying just that. The philosopher Jean Piaget is quoted as pointing out that whereas academic geometry moves from measurement to shape analysis then along to topology, a child's intuition goes the other way: topological (how many holes?) through to identifying shapes, and finally to measurement. A major problem as noted here — and still unsolved — is the vexed issue of how much geometry to include in any curriculum, and where it should go? The panoply of new computational tools ('Dynamic Geometry Software') such as Cabri Geometry, Geometers Sketchpad, GeoGebra, Cinderella don't so much as solve this problem as bring problems about curriculum design and sequencing into 'sharp relief'. The authors note that research into the use of such tools for learning geometry is relatively new, but seem to consider that such tools can have — and indeed, should have — a part in any modern curriculum.

The next chapter, 'Reasoning about data', looks at statistics, and wonders if mathematics educators should be teaching statistics at all, or whether it is in fact a separate discipline. Statistics certainly spreads across the curriculum, but simply for practicality it seems unlikely that in a school to be taught by anybody other than a mathematics teacher. The chapter notes some research gaps: for example, how do children conceive of a 'sample'? The authors point out that graphing tools (such as TinkerPlots) are invaluable in allowing students to reason about data 'without an impossible threshold of calculation and graphing to overcome'. And indeed, one of the pleasing aspects of the book in general is the authors' implicit — and at times explicit — approval of technology as a valid and valuable teaching tool. The following chapter, 'Reasoning about uncertainty' follows on naturally from statistics, and again the use of graphical tools is noted. There is a whistle-stop tour through some research about the understanding of chance, of randomness, and on the use of simulations with a software tool. Much about probability learning is under-researched, including student reasoning about situations which are only partly determined, as well as risk-analysis, or rather risk-based decision making. It is clear that our knowledge of how children of any age — and learners in general — learn about probability, randomness and risk is surprisingly sketchy. And this should be no surprise, given the general poor understanding across the population.

The final two chapters, on functions, and on moving beyond school, look at matters which, for many tertiary educators, are major issues: the difficulty many students have of moving between functional, graphical, and tabular representations of a function; and also of different representations of a function. For example, a quadratic function may be equally represented as $y = ax^2+bx+c$, $y = a(x-b)^2+c$, $y = a(x-b)(x-c)$ and yet students may well be mystified by a representation different to the one they already know. They may know that for $y = ax^2 + bx + c$ the value c is the y-intercept, but what is the y-intercept in $y = a(x-b)^2 + c$? For that matter, what *do* the values a, b and c represent? And as with most areas of mathematics, there is no research which indicates that there is a 'best' sequence for teaching about functions. The final chapter briefly discusses trigonometry, and difficulties encountered in moving from $\sin(x)$ as a triangle measurement to a real-valued, and then complex-valued function; calculus and analysis—differentiation, and ϵ-δ proofs of continuity and differentiability; and finally formal statistical inference. At these levels there is very little research, and the authors frankly admit that much is unknown about how these students learn, and what practices may best support their learning.

A few final remarks

This book is not about how to teach mathematics, although it contains plenty of good ideas, especially about sequencing of topics. It is a synthesis of recent research about how children of various ages learn specific mathematical topics, and about how much is still unknown.

There are several strands running through the book, of which two of the strongest (so it seemed to me) were the importance of context ('what's this stuff used for?') and the promise of technology.

It is no secret, given the general innumeracy of much of the population, that mathematics teaching has a long way to go. I think that this neat, accessible book should be widely read: by mathematics teachers, by mathematicians, by educational policy makers. The more we understand how children (and older students) learn mathematics, and the sorts of misunderstandings that impede their progress, the better we will be able to build a curriculum which engages, enthuses, and excites its audience.

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The Fascinating World Of Graph Theory

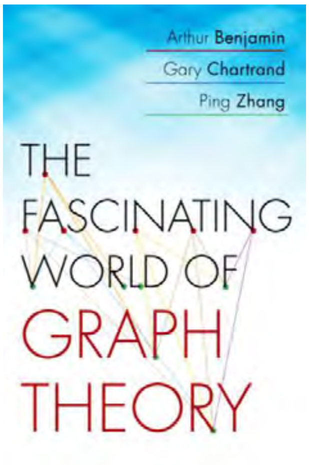
Arthur Benjamin, Gary Chartrand and Ping Zhang
Princeton University Press, 2015, ISBN 978-0-691-16381-9

Over the years many people have asked me about the usefulness of mathematics in some endeavour that interests them. What I have discovered is that the ensuing conversation is largely driven by the poser's mathematical background. People who have taken no mathematics past high school or only a course or two at the tertiary level do not understand what mathematics brings to the table. Many times I have begun an explanation of an approach to a problem and the typical response is 'That's mathematics?' Therein lies one of the problems facing mathematics and mathematicians, namely, the vast majority of people do not know what mathematics is. Unfortunately, many of those people are in influential positions in society.

An interesting question, given the above comments, is what should we offer in the way of a course to a college student who is going to take a single mathematics course? This review is not going to make any attempt to discuss such a highly loaded question. However, I have raised the issue because the book under review has been written from the viewpoint of what graph theory is about and the kinds of contexts in which graph theory may be used as a model for a realistic problem. It could well serve as the kind of book we would give to someone wanting to learn something about the spirit of mathematics.

Chapter one deals exclusively with games, puzzles and problems that may be modelled using graphs. The models are introduced along with a basic description of what graphs and multigraphs are, and how they are used to capture the situations under consideration. This material would be understandable to a curious intelligent person with only a basic mathematical background. Such a person might even think to herself/himself that much of the discussion deals with problems they might not have considered as mathematics prior to reading the book.

The second chapter introduces the notion of classifying graphs in some way. The basic idea of isomorphism is introduced, pushing the boundaries of thinking about degree, and the first discussion of an unsolved problem arises. This is done via the reconstruction problem. Introducing the reader to the fact that there are problems which have not yielded to vast research efforts likely is an eye-opener for many of them. I have met a fair number of people who wonder what one can possibly research in mathematics.



Chapter three introduces basic notions revolving around connectivity and distance. Both vertex and edge cuts are discussed along with several interesting applications. In addition, there is a charming discussion of both Erdös numbers and pseudonyms several groups have used for publications. Another characteristic of the book continues to emerge here. There are five theorems stated in this chapter and three of them are given without proof.

Chapter four introduces trees and basic properties of these useful objects. Cayley's formula for labelled trees is treated thoroughly as are minimal spanning trees. I would have liked to have seen a discussion of Steiner trees for two reasons. First, there are nice examples of their usefulness compared to minimal spanning trees. Two, the huge gap in difficulty between trying to find a minimal Steiner tree and a minimal spanning tree is a nice illustration of how a small tweaking of what one is looking for in an application may profoundly change the problem.

Chapters five and six deal with graph traversals. There is a nice discussion of both Euler tours and the Chinese Postman Problem, both of which are edge traversals, in the first of the two chapters. The book is richly infused with history and background. One item which particularly delighted me, and relates to my comments at the beginning, was the following excerpt from a letter written by Euler to the mayor of Danzig after the former had solved the Königsberg bridges problem.

> Thus you see, most noble Sir, how this type of solution bears little relationship to mathematics, and I do not understand why you expect a mathematician to produce it, rather than anyone else, for the solution is based on reason alone, and its discovery does not depend on any mathematical principle. Because of this, I do not know why even questions which bear so little relationship to mathematics are solved more quickly by mathematicians than by others.

Vertex traversals are covered in Chapter six. These are, of course, Hamilton cycles and there is a nice discussion of the history behind this topic. The chapter concludes with a discussion of the Travelling Salesman Problem which is a famous and important optimization problem involving Hamilton cycles. It is in some sense the vertex analogue of the Chinese Postman Problem although the latter allows traversal of an edge more than once, whereas, the Travelling Salesman Problem allows passage through each vertex precisely once.

Chapters seven and eight deal with graph decompositions, that is, partitions of the edge set of a graph. Chapter seven restricts itself mostly to matchings, perfect matchings and decompositions into perfect matchings. There is a brief excursion into decompositions into 2-factors. The subsequent chapter deals with other decomposition problems with an emphasis on cycle decompositions. The chapter concludes with a detailed analysis of the puzzle known by many names, but probably the best known contemporary name is Instant Insanity.

Chapter nine begins with an interesting history of Herbert Robbins whose only paper in graph theory dealt with orienting a graph so that the resulting digraph is strongly connected. This chapter deals with orientations of graphs with an emphasis on tournaments, that is, orientations of complete graphs. The chapter concludes with a nice application of tournaments for voting schemes.

The material in Chapter 10 is well-presented standard material on topological graph theory. However, I confess that I was disappointed because when I first saw only the title of the chapter, I was pleased to see the inclusion of material on graph drawing. I say this because the topic almost is never discussed in a book, and I know of several companies whose primary business is essentially producing nice drawings of graphs. So the thought that a reader was going to be exposed to some of the subtle ideas in trying to convey information to the public, board members, employees, etc. via nice drawings of various relational structures was appealing.

The last two chapters deal with colouring. Chapter 11 looks at vertex colouring while Chapter 12 deals with edge colouring. Consistent with the rest of the book, there is an interweaving of history, motivation, applications and basic results.

The book is rich with history and really brings life to the people who have developed the subject of graph theory. The authors have done a splendid job of showing the reader that thinking about and doing mathematics is a human endeavour. Anyone reading this book will take that away for certain. That brings us to the ultimate question: Who is going to find this book useful?

The book would be attractive to an intelligent reader who knows some mathematics and would like to get insight into graph theory. The level is such that a rich background in mathematics is not necessary. There are proofs but almost all are easy to follow.

I don't believe this book would work well for the standard presentation of a course on graph theory. I do believe it would work well for a group of students who are prepared to read, think about what they read, be prepared to discuss what they are reading, and willing to explore items arising from their discussions. Most of us do not have the luxury of teaching courses in such a manner. There is a very good set of exercises helping in developing ideas arising in the book.

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Lozanovsky's Notebooks

Grigorii Yakovlevich Lozanovsky

Translated from the Russian by Marek Wójtowicz

Part I. Edited by Włodzimierz Odyniec, Aleksandr I. Veksler and Marek Wójtowicz. Pedagogical University of Zielona Góra Press, Zielona Góra, 2000. ISBN: 83-7268-031-0

Part II. Edited by Marek Wójtowicz. Kazimierz Wielki University Press, Bydgoszcz, 2012. ISBN: 978-83-7096-855-7

Part III. Edited by Marek Wójtowicz. Kazimierz Wielki University Press, Bydgoszcz, 2012. ISBN: 978-83-7096-862-5

This is a very interesting and unusual piece of mathematical writing. The only immediate analogue which comes to mind is a comparison with the famed 'Scottish book' used by members of the Lvov Mathematical School to jot down various mathematical problems, and which determined later an early development of Banach space geometry. The books under review are an English translation from the Russian original due to an outstanding Russian mathematician, Grigorii Lozanovsky[1]. From the outset, I must emphasize a host of difficulties which were facing the translators and editors, primarily Marek Wójtowicz, who undertook this mammoth task. Indeed, the project began only in 1998, long after the untimely death of the author in 1976. The three volumes of the book consist of 2223 Problems/Questions/Remarks which are frequently supplied with many comments by A.I. Veksler, L. Maligranda, M. Mastyło, W. Odyniec, W. Wnuk, D. Yost and the scientific editors.

Lozanovskii was a leader in the St. Petersburg school of Banach lattices and semi-ordered spaces and his life and work has left an indelible trace on his friends and associates. I did not meet Lozanovskii in person, but I had heard about him from many former colleagues from St. Petersburg (and also from my native Tashkent) who have always referred to him as 'an outstanding mathematician and human being'. The text of his notebooks confirms the incredible power of Lozanovskii's insight concerning interesting and important questions about (special classes of) Banach lattices and Function Spaces, Interpolation Theory and various parts of Banach space theory, and a host of other topics which he came across. The text also is a testament to his enormous passion for Mathematics. The text was not intended for publication and is unstructured; the work done by the editors and translators is simply outstanding. He has made an important contribution to Interpolation Theory, in particular to the complex method of interpolation. I will especially emphasize two outstanding contributions made by Lozanovskii. One of the most important constructions in Interpolation Theory is now named the Calderón-Lozanovskii construction (see e.g. [18]) to properly credit his contribution to that area. A reader can observe through Problems 636, 973, 987, 1000,

[1] Lozanovskii would be a more suitable transliteration of the surname.

1364, 1467, 1472, 1605, 1780, 1861 how thoroughly Lozanovskii developed that construction and studied its properties. This construction retains its importance until now and practically anyone who would be interpolating couples of Banach lattices (or their noncommutative counterparts) would be using (some form of) Lozanovskii's results. From my personal experience, I can cite a recent paper [5] in which questions related to noncommutative integration (relevant to the noncommutative geometry of Alain Connes [8]) were treated with substantial use of the ideas underlying the Calderón–Lozanovskii construction. Another outstanding result by Lozanovskii is his factorization theorem stated in Problems 628 and 629 in the second volume of the Notebooks. This theorem asserts that the pointwise product of any Banach function space E with the Fatou property and its Köthe dual E' is an L_1-space. For a far reaching generalization of Lozanovskii's factorization theorem I refer to a very recent paper [13] (I thank L. Maligranda for this reference).

Of course, some of the problems stated (or, frequently, somewhat vaguely suggested) in his notebooks have lost their shine, and it is not surprising, after all the publication has come almost 40 years too late .... However, even now I can assure experts (and simply people who have an interest in these parts of Mathematics) that their reading would be a richly rewarding experience. I will try to convince a reader by my own example: in this review I shall identify several topics from the notebooks, which are very close to my own research (and heart) and which were (with incredible insight) identified and 'predicted' by Lozanovskii. However, prior to referring to my own experience, let me state unequivocally that Lozanovskii had an incredible ability to unmistakably identify central problems in Banach lattices and allied areas of Banach space geometry. Just one example: Problems 409 and 463 are directly relevant to the famous unconditional basic sequence problem resolved by Gowers and Maurey [10] in 1993. More examples of that kind can be found, however, it is easier for this reviewer to concentrate on those problems in the book with which he is well familiar and which at the same time have not been discussed in the comments of subsequent commentators. My list is intended to convince the potential readers of the incredibly wide spectrum of Lozanovskii's interests and deep interconnections which he surmised.

Problem 132 asks whether the triangle inequality $|A+B| \leq |A|+|B|$ holds for two Hermitian and non-commuting operators on a Hilbert space. This question has been thoroughly investigated in [22] and answered there in the negative. However, a positive answer can be given if we replace the classical order on the set of all Hermitian (bounded) operators with the (so-called) submajorization (or else, Hardy–Littlewood–Pólya) preordering (see also [17]). The latter inequality plays a useful role in various questions concerning the geometry of symmetric operator spaces, which are a noncommutative extension of classical rearrangement invariant function spaces (see [7], [17] and the references therein).

Problems 654 and 1123 are concerned with Lozanovskii's observation that a combination of (local) measure convergence and weak convergence in Lebesgue spaces L^1 on σ-finite measure spaces yields norm convergence. In Problem 654, he suggested to thoroughly examine this property. It should be pointed out that this property is strongly linked with the classical characterization due to Dunford and Pettis of relatively weakly compact sets in L_1-spaces. In particular, a bounded subset A of any abstract L-space is relatively weakly compact if and only if each disjoint sequence in its solid hull converges in norm to zero. In turn, each of these statements is equivalent to the assertion that A is of uniformly absolutely continuous norm. This leads naturally to a study of spaces with the property that norm convergence of sequences is equivalent to weak convergence plus convergence for the measure topology. The study of such spaces seems to have been initiated in [14] and [15], where the term (wm)-property (for rearrangement-invariant spaces with such a property) was coined. The study of such spaces has been on-going for the last two decades and the author of the present review is in a position to give an update.

The analogue of the Dunford–Pettis criteria for the classical Lorentz spaces was obtained in [23] and later, in [6, Corollary 1.4] it was established that every Lorentz space Λ_ϕ has the (wm)-property. Orlicz spaces on the interval $[0, 1)$ with property (wm) have been fully characterized in [1]. Finally, in [9, Proposition 6.10] it is shown that, in rearrangement-invariant function spaces on measure spaces with finite measure possessing the property (wm), each relatively weakly compact subset is of uniformly absolutely continuous norm. The latter result does not hold when the measure space is equipped with an infinite measure. Furthermore, the just cited results hold also in a much greater generality when rearrangement-invariant function spaces are replaced with their noncommutative counterparts [9].

Problem 1520 asks whether every separable symmetric space $E \neq L_1$ is the intersection of two nonseparable symmetric (or, rearrangement-invariant) spaces. It is not specified by Lozanovskii whether he meant symmetric function spaces on $(0, 1)$ or on $(0, \infty)$.

This problem has been very recently resolved in the affirmative by E.M. Semenov and the reviewer. Theorem 9 in [24] yields the following result.

Theorem 1. *Let E be a symmetric function space either on $(0, 1)$ or on $(0, \infty)$ such that $E, E^\times \neq L_1, L_1 \cap L_\infty$. There exist symmetric function spaces $E_1 \neq E$ and $E_2 \neq E$ such that $E_1 \cap E_2 = E$.*

Here, $E^\times$ is the Köthe dual of the symmetric space E defined by the formula

$$E^\times = \{y \in L_1 + L_\infty : xy \in L_1, \text{ for all } x \in E\},$$
$$\|y\|_{E^\times} = \sup\{\int |xy| : \ \|x\|_E \leq 1\}.$$

In [24], the nonseparability of the spaces E_1 and E_2 is not explicitly stated. However, by the construction in [24], we have $E_1 = E + M_{\psi_1}$ and $E_2 = E + M_{\psi_2}$, where M_{ψ_1}, M_{ψ_2} are certain Lorentz (or, Marcinkiewicz) spaces. Since Lorentz spaces M_{ψ_1}, M_{ψ_2} are nonseparable, it follows that so are E_1 and E_2.

Finally, Lemma 8 in [24] states that $E, E^\times \neq L_1, L_1 \cap L_\infty$ unless E is one of the following spaces: L_1, L_∞, $(L_\infty)_0$, $L_1 + L_\infty$, $(L_1 + L_\infty)_0$, $L_1 \cap L_\infty$.

Problem 1843 refers firstly to Makarov's proof of the following lemma. I thank Dmitriy Zanin who has suggested the following simple proof.

Lemma 1. *Let* f_n, $n \geq 0$, *be positive, independent and identically distributed functions. We have*

$$\sup_{n \geq 0} f_n = \|f_1\|_\infty$$

almost everywhere.

Proof. Fix a finite number $0 < M < \|f_1\|_\infty$ and consider the function $h = M\chi_{(M,\infty)}$. Clearly, the functions $h(f_n)$, $n \geq 0$, are also independent. Since $f_n \geq h(f_n)$ for every $n \geq 0$, it follows that

$$\sup_{n \geq 0} f_n \geq \sup_{n \geq 0} h(f_n) \geq \sup_{0 \leq n < N} h(f_n) = M\chi_{\mathrm{supp}(\sup_{0 \leq n < N} h(f_n))}.$$

By independence,

$$m\Big(\mathrm{supp}\Big(\sup_{0 \leq n < N} h(f_n)\Big)\Big) = 1 - (1 - m(\mathrm{supp}(h(f_1))))^N.$$

Passing to the limit as $N \to \infty$, we obtain that

$$\sup_{n \geq 0} f_n \geq M.$$

Since $M < \|f_1\|_\infty$ is arbitrary, the assertion follows. □

If f_n are positive, independent, identically distributed unbounded functions, then the positive answer to the Lozanovsky question follows by applying the lemma above to the sequence f_{n_k}, $k \geq 0$.

Problem 1900 (attributed to E.M. Semenov) asks whether two linearly homeomorphic symmetric spaces coincide. This innocent looking question has underlined the most deep developments in Banach space theory of symmetric function spaces. I refer to two outstanding books [11], [16], which contain a wealth of information relevant to this question. Theorem 37 in [2] answers this question in the negative via methods drawn from probability theory. The latest information concerning uniqueness of symmetric structure can be found in [3].

Problem 2099 concerns Braverman and Mekler's paper [4]. The conjecture made in this problem is resolved in the affirmative in [4]. However, this condition fails to be necessary as shown in [12]. Indeed, for every Orlicz space L_Φ the assertion stated in Problem 2099 holds true, but it is not necessarily the case that

$$\lim_{r \to \infty} \frac{1}{r} \|\sigma_r\|_{L_\Phi \to L_\Phi} = 0.$$

A necessary and sufficient condition has been recently found in [12].

Problem 551 asks whether $B_1 \wedge B_2$ is a Banach limit when B_1 and B_2 are Banach limits. Observing that the shift operator T is a bijection from $l_\infty/c_0 \to l_\infty/c_0$, we infer that its adjoint $T^* \colon (l_\infty/c_0)^* \to (l_\infty/c_0)^*$ is also a bijection. It follows that T^* preserves the operation $\wedge$, that is

$$T^*(B_1 \wedge B_2) = T^*B_1 \wedge T^*B_2 = B_1 \wedge B_2.$$

Hence, $B_1 \wedge B_2$ is translation invariant and positive. Hence, $B_1 \wedge B_2$ is a multiple of a Banach limit. It does not have to be a Banach limit because $B_1 \wedge B_2 = 0$

when B_1 and B_2 are distinct extreme points of the set $\mathfrak{B}$ of all Banach limits (see Lemma 1 in [25]).

One of the most useful applications of Banach limits is in the construction of singular traces [19], [21], which form an analogue of integration in A. Connes' non-commutative geometry [8]. In this context the set of almost convergent sequences is used to describe so-called measurable operators [21]. The reduction of a trace to the respective Calkin space is a symmetric functional (see [17]).

Problem 2054 asks whether the dual $M(\psi)^*$ of the Lorentz space $M(\psi)$ contains a set which consists of pairwise disjoint elements and whose cardinality is that of $\mathbb{R}$. If one replaces $M(\psi)$ with the weak L_1-space, $L_{1,\infty}$, then a very strong form of a positive answer exists. It is proved in [21] (see also [19]) that there is an order-preserving linear bijection between the set of all symmetric functionals on $L_{1,\infty}$ and that of all continuous translation invariant functionals on l_∞ (read, multiples of Banach limits). It is proved in Lemma 1 in [25] that every 2 distinct extreme points of the set $\mathfrak{B}$ of all Banach limits are disjoint. Since (see e.g. proof of Theorem 11.1 in [20]) the set $\mathfrak{B}$ of all Banach limits has the cardinality 2^c, it follows that there is a set of symmetric mutually disjoint functionals on $L_{1,\infty}$ whose cardinality is 2^c.

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Nalini Joshi*

The Impact of Advanced Physical and Mathematical Sciences to the Australian Economy

There has been a succession of reports released recently, which should be in the armoury of every mathematical scientist in the country. Are you looking for punchlines that you can convey to a journalist or a member of parliament? Or, for quotes to add weight to an argument for further investment in mathematical sciences and its benefit to society? The latest reports have delivered information and data that have been worth their weight in gold.

You have probably read recent news headlines, one of which was 'Physics, chemistry and mathematics add billions to the economy, report finds.'[1] This was a news item about the report 'The importance of advanced physical and mathematical sciences to the Australian economy' released by the Australian Academy of Science on 25 March 2015. It was commissioned by the Office of the Chief Scientist and the Australian Academy of Science and prepared by economists from the Centre for International Economics.[2]

It focuses on 'advanced physical and mathematical sciences' (APM), that is, on physics, chemistry, the earth sciences and mathematical sciences and on their applications in the past 20 years. The main finding (stated in the foreword) of this report is

> The direct contribution of the advanced physical and mathematical sciences is equal to 11% of the Australian economy (that is, about $145 billion per year). Along with the direct contribution, the report estimates additional and flow-on benefits of another 11%, bringing total benefits to just over 22% (around $292 billion per year).

The report's investigations started with a study of the share of the APM sciences in the 2006 Australian and New Zealand Standard Industrial Classification (ANZSIC), in which there are 506 industry classes. The National Committee for Mathematical Sciences was asked to recommend mathematical scientists to take part in the initial workshop to consider how much and to what extent APM plays a role in each classification. We proposed Professor Nigel Bean (Adelaide), Mr

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[1]http://www.abc.net.au/news/2015-03-25/sciences-sector-add-billions-to-the-economy-report-finds/6345648, accessed 25 March 2015.

[2]The report can be downloaded from https://www.science.org.au/publications/science-impacts-economy.

Stephen Horn (SSAI) and Professor Geoff Prince (AMSI), who took part in this two-day workshop. Further industry consultation was undertaken to clarify and support the outcomes.

In a previous NCMS column 'How mathematical sciences add value to the national economy'[3] I described the methodology and measurement of direct and indirect value added to the economy in the Deloitte assessment of the economic impact of mathematical sciences on the Dutch economy. The methodology of the Australian report is similar, except for the fact that APM disciplines were considered as a multidisciplinary enterprise, rather than as separate disciplines. Rather than repeat a description of the methodology, I will highlight some of the distinctive findings of the Australian report here.

1. Employees who hold a non-school qualification (NSQ) in the APM sciences are broadly spread across the economy (p. 31). In particular, 538 out of the 717 ABS industry classes from the 2011 census had at least one employee with a NSQ in the APM sciences. In other words, 'APM scientific skills are valuable to businesses in many parts of the economy, whether or not those businesses are strictly science-based.'
2. In Australia, the APM sciences feature more prominently in: the mining sector (including oil and gas extraction, iron ore mining and gold ore mining), the finance sector (including general insurance and banking) and the communications sector (including wired telecommunications network operations) (p. 55). Pathology and diagnostic imaging services is also prominent, occurring in the top six industry classes.
3. While the direct impact of the APM sciences on the economy was \$145B, its flow on or indirect impact on all industries (whether or not they use the APM sciences) and to consumers added another \$147B to the economy (p. 60).

As mathematicians, we know the depth and importance of mathematical sciences to many areas in our lives. The report's authors repeatedly state that the figures reported above are *underestimates* of the true value added by advanced physical and mathematical sciences to our economy. While no report is perfect, I for one am grateful to have this one in the arsenal I can pull out to convince people who may never have studied any mathematics beyond high school that mathematics is not only worth pursuing but is essential for the economic health of our society.

Nalini Joshi is an ARC Georgina Sweet Laureate Fellow and the Chair of Applied Mathematics at The University of Sydney. She was the President of the Australian Mathematical Society during 2008–2010, elected a Fellow of the Australian Academy of Science in 2008, became the Chair of the National Committee of Mathematical Sciences in 2011, and was elected to the Council of the Australian Academy of Science in 2012.

[3]http://www.austms.org.au/Publ/Gazette/2014/Sep14/NCMS.pdf

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AMSI-CARMA Lecturer

Prof. Jeremy Avigad

Carnegie Mellon University

Jeremy Avigad is a Professor of Philosophy and Mathematical Sciences at Carnegie Mellon University, with research interests in mathematical logic, proof theory, philosophy of mathematics, formal verification, automated reasoning, and the history of mathematics.

Lectures:

Formal methods in mathematics
2–3pm, 8 May 2015

Automated theorem proving
3–4pm, 8 May 2015

Interactive theorem proving
2–3pm,15 May 2015

Formal methods in analysis
2–3pm, 22 May 2015

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AMSI News

Geoff Prince*

National Research Centre: next steps

On 25 February 2015 the inaugural meeting of prospective partners in the proposed National Research Centre in the Mathematical Sciences (NRC) took place at AMSI. These stakeholders included the AMSI membership, research hotspots including various Centres of Excellence, learned societies and government agencies. The purpose of the meeting was to elaborate and refine the vision for the centre and to get the necessary business planning underway. As a result of the discussions at the meeting I created this statement of purpose upon which I invite comment from *Gazette* readers. Of course, I take sole responsibility for its contents. I favour the current consensus for a mix of distributed programs along with the establishment of an international research station.

National Benefits

- The significant growth of high quality research outputs through programs funded publically and privately
- The strengthening of mathematical sciences in all of Australia's universities and research agencies
- The establishment of Australia as a research destination on the international scene
- The establishment of a nationally owned, international research station
- The networking of Centres of Excellence and the enhancement of their connectivity with agencies and universities
- A vehicle to broker partnerships and funding agreements, nationally and internationally (cf. the NSF funding for the Banff Research Station)
- A hothouse for mathematical sciences start-up companies
- The establishment of deep and productive connections between the universities, agencies and the private mathematical sciences sector
- Genuine deep research engagement with other research disciplines and business and government sectors
- The growth of research training and its strategic alignment with national research and recruitment goals both theoretical and applied, public and private
- Increased public awareness of the role of the mathematical sciences in 21st century science, technology, innovation, the social sciences and commerce

Benefits to Partners

- Partner programs strengthened and defended where necessary
- Local profiles raised
- Local programs used as in-kind contribution to NRC

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- Increased local activity via NRC engagement and funding
- Increased external engagement via NRC network
- Lowers costs of, and barriers to, collaboration, especially for the research agencies and smaller university departments
- Replaces ad hoc collaborations with strategically sourced ones
- Local key performance indicators boosted through shared programs
- Establishment of a strong communication channel with funding bodies and policy makers (i.e. a strong lobby group)

Interim Structure

- Interim structure for three years
- National Research Director appointed
- Research station scoped with a view to early establishment
- Partners continue to deliver their own programs
- Partner programs co-badged as NRC
- NRC runs over-arching programs e.g. MPE Australia
- Ongoing funding from government and private sector secured
- Governance structure created

Programs at maturity

- Conventional theme programs (6–12 months)
- Three-year funded programs
- High profile international workshops and themes at research stations (cf. Banff, Oberwolfach)
- Research in Pairs
  cf. http://www.mfo.de/scientific-programme/long-term/research-in-pairs
- Small grant scheme
- Commercial start-up support scheme
- National postgraduate training integrated across sectors
- Postdoctoral coursework programs
- Outreach
- International partnerships
- Joint NRC/ARC and NRC/NHMRC programs
- Joint international programs
- Expanded graduate schools eg optimisation, big data, computational science, security

Funding for years 1–3

- Business Plan — AMSI to fund writing \$50k max
- Business Plan to raise initial total of \$1.2m for salaries:
  Director and EA, fund raising and event manager ˜\$415k pa for three years
- Program costs \$250k pa to be raised by the NRC team
- Ongoing funding in excess of \$5m pa to be raised by NRC team

Frequently Asked Questions

1. Why not just let AMSI do this?

AMSI is seen by government and other potential stakeholders as a single entity rather than a national collaboration. This may have been what cost us our significant (in $ and activity terms) bid for an Australian Mathematics and Science Partnership Project award.

A collaborative approach including agencies, CoEs and private partners should overcome this perception and indicate broad benefit. It should also widen the future funding base.

2. Why spend $415k over three years on salaries for a research director, etc. when the money could be spent on programs?

(a) The purpose of these positions is to raise the capital and put the structures in place for a full-blown sustainable centre. AMSI does not have the current capacity to do this.

(b) AMSI does not currently have the human capacity to run these extra programs even if the cash was available.

(c) The thinking implicit in the question will not deliver the sort of centre on the scale that we want.

3. This process will take too long; for example we will have to wait at least three years for a research station to be established.

While I can't pre-empt the decision making around the business plan there is a prima facie case for beginning research station programs early at a temporary location but with a clear external identity.

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We expect to run open access meetings once the business planning gets underway in June but please give me a call or send me an email to discuss any aspect of this proposal.

Reminder: our next workshop application round closes on 5 June 2015.

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.

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BioInfoSummer

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General News

Mathematics and young women

On Tuesday 28 April, AMSI and the BHP Billiton Foundation launched *Choose Maths*, a five-year national program to turn around public perceptions of mathematics and statistics as study and career choices for girls and young women.

Choose Maths begins with a focus on mathematics education in our schools. The BHP Billiton Foundation has contributed $22 million toward the partnership, which will enable AMSI to expand its schools outreach capacity.

The program will contribute to the health of the mathematics pipeline in Australia from primary through tertiary education and out to industry and the workplace by:

- developing a national mathematical sciences careers awareness campaign;
- establishing an 'inspiring women in mathematics network';
- expanding mathematics teacher professional development;
- holding annual BHP Billiton awards for excellence in the teaching and learning of mathematics.

For further details of the program, see
http://amsi.org.au/2015/04/28/bhp-billiton-foundation/.

For other media reports, see
http://www.womensagenda.com.au/talking-about/top-stories/bhp-billiton-invests-%2422-million-in-women-studying-maths/201504295674#.VVUsQvnzrrf
http://www.miningaustralia.com.au/news/bhp-billiton-wants-more-girls-to-study-maths
http://www.afr.com/leadership/management/productivity/bhp-backs-maths-for-girls-with-22m-20150428-1mumnn.

Mathematics in the media

- Lily Serna, a member of the AMSI Board since 2012, and previously host of the SBS program Letters and Numbers, reflects on social attitudes toward women and maths and her career path at
http://www.abc.net.au/science/articles/2015/04/28/4223215.htm.
- Ron Steinfeld from Monash has had an excellent introductory article on cryptography published in *The Conversation*, 23 March 2015, entitled 'Encryption today: how safe is it really?': https://theconversation.com/encryption-today-how-safe-is-it-really-37806.
- Chief Scientist Professor Ian Chubb addressed the National Press Club on 25 March as part of the two-day Science Meets Parliament event, following the release earlier in the day of the Australian Academy of Science report 'The importance of advanced physical and mathematical sciences to the

Australian economy'. The full text of his speech is at
http://www.chiefscientist.gov.au/2015/03/keynote-address-to-the-national-press-club-for-science-meets-parliament-2/.

On-line Professional Development

The AustMS website is the home of the on-line professional development unit *Effective Teaching, Effective Learning in the Quantitative Disciplines*. The unit was developed under an ALTC grant, by a project team of mathematicians, and is now in its fifth year. The unit is being coordinated from La Trobe in 2015 (on behalf of the AustMS Standing Committee on Mathematics Education).

The unit is available free to AustMS members, and also to reciprocal members. The modules are available for all to view; by formally enrolling and completing three assessment tasks, participants can receive a certificate of completion. By negotiation with your home institution, you may be able to substitute this discipline-based unit for more generic teaching-and-learning training that they require, or as one unit in a Graduate Certificate of Higher Education, as some participants have already done.

The unit is suitable both for tutors and lecturers. The assessment tasks must be completed when one is teaching a class, as they involve production of teaching and assessment materials and reflection upon them.

It is intended to run the unit again in second semester. For more information, contact the unit coordinator Dr Katherine Seaton (k.seaton@latrobe.edu.au) or visit the unit website: http://www.austms.org.au/Professional+Development+Unit.

The unit outline, and details of assessment, may be viewed there.

Public lecture at UNSW

On 2 February, UNSW hosted a public lecture by Professor Franco Vivaldi, on 'The Arithmetic of Chaos'. The lecture was part of that week's Workshop on Algebraic, Number Theoretic and Graph Theoretic Aspects of Dynamical Systems.

Young Mathematician's Day

Eighty-five Year 9 and 10 students from across the Hunter, their teachers, a handful of mathematicians and four University of Newcastle mathematics undergraduates worked together for a day as part of the UoN's Young Mathematician's Program recently. Organised by Dr Malcolm Roberts and supported by Dr Andrew Kepert (Ourimbah) and Bob Ous from Newcastle Mathematics Association, the day was the first in a series of opportunities the program provides throughout the year. The program enables students to learn about how mathematicians approach solving both pure and applied problems, and gain the experience of working like a mathematician.

Completed PhDs

ANU

- Dr Mathew Langford, *Motion of hypersurfaces by curvature*, supervisor: Ben Andrews.

Deakin University

- Dr Moutaz Alazab, *Analysis on smartphone devices for detection and prevention of malware*, supervisor: Lynn Batten.
- Dr Tim Wilkin, *Weakly monotonic averaging with application to image processing*, supervisor: Gleb Beliakov.

Royal Melbourne Institute of Technology

- Dr Colin Xu Chen, *Modeling of atherosclerotic plaque growth using fluid-structure interaction*, supervisors: Yan Ding, John Anthony Gear and John Shepherd.
- Dr Ummul Fahi Abdul Rauf, *A copula-based analysis of flood phenomena in Victoria, Australia*, supervisors: Panlop Zeephongsekul and Cliff da Costa.
- Dr Xu Zhang, *Game theoretical approach in supply chain management*, supervisors: Panlop Zeephongsekul and Mali Abdollahian.
- Dr Reza Roozbahani, *Use of advanced operations research methods of optimal water allocation modelling*, supervisors: Sergei Schreider and Babak Abbasi.
- Dr Jon Plummer, *Optimisation of network systems for gas and water allocation and spot price dynamic modelling*, supervisors: Sergei Schreider and Andrew Eberhard.

University of Adelaide

- Dr Meng Cao, *Modelling environmental turbulent fluids and multiscale modelling couples patches of wave-like system*, supervisors: Tony Roberts and Ben Binder.

University of Melbourne

- Dr Alexander Lee, *Discretely holomorphic observables in statistical mechanics*, supervisors: Jan de Gier and Jorgen Rasmussen.

University of Newcastle

- Dr Daniel Sutherland, *Arithmetic applications of Hankel determinants*, supervisors: Michael Coons, Wadim Zudilin and Jon Borwein.

University of New South Wales

- Dr Francis Hui, *Mixing it up: new methods for finite mixture modelling of multi-species data in ecology*, supervisor: David Warton.

University of Queensland

- Dr Robert Cope, *Animal movement between populations deduced from family trees*, supervisor: Phil Pollett.
- Dr Dejan Jovanovic, *Fault detection in complex and distributed systems*, supervisor: Phil Pollett.
- Dr Andrew Smith, *Spatially structured metapopulation models within static and dynamic environments*, supervisor: Phil Pollett.

University of Sydney

- Dr Clinton Boys, *Alternating quiver Hecke algebras*, supervisor: Andrew Mathas.
- Dr John Maclean, *Numerical multiscale methods for ordinary differential equations*, supervisor: Georg Gottwald.
- Dr Gareth White, *Algorithms for Galois group computations over multivariate function fields*, supervisors: Steve Donnelly and Claus Fieker.
- Dr Chong You, *Model selection and estimating degrees of freedom in Bayesian linear and linear mixed models*, supervisors: Samuel Mueller and John Ormerod.

University of Wollongong

- Bothaina Buckhatwa completed her PhD thesis entitled *Improving mathematics education in the Middle East: A focus on technology, learning design and professional development*. Bothaina passed all examiners, postgraduate committee etc., but she has not been awarded her degree because the Libyan government has not paid the fees for its students.

Awards and other achievements

University of Adelaide

- Chen Chen was awarded the 'Chinese Government Award for Outstanding Self-Financed Students Abroad' by the China Scholarship Council.

University of Melbourne

- The Academy of Science awarded an AK Head Travelling Fellowship to Mr Yi Huang.

University of New South Wales

- PhD student Isaac Donnelly has won a Fulbright Scholarship. He will be going to Northeastern University in Boston from August 2015 till June 2016, where he will be working with Professor Barabasi, a leading figure of network science.

- Associate Professor Moninya Roughan has been chosen by the Chinese Recruitment Program of High-end Foreign Experts of the State Administration of Foreign Experts Affairs for a fellowship which will allow her to spend six months in Shanghai over a three-year period.

University of Sydney

- Nalini Joshi has been elected as a Fellow of the Royal Society of NSW.

University of Western Australia

- Professor Cheryl Praeger has been inducted into the Western Australia Women's Hall of Fame. In the Hall of Fame, she joins other eminent WA women including Foreign Minister Julie Bishop, Perth Lord Mayor Lisa Scaffidi, Professors Fiona Stanley and Fiona Wood and former WA Premier and UWA academic Carmen Lawrence. For further details see http://www.news.uwa.edu.au/201503067390/awards-and-prizes/womens-hall-fame-professor-proves-women-can-do-vital-maths.

University of Western Sydney

- Associate Professor Roozbeh Hazrat has been awarded a Humboldt Fellowship for 2015/16.

University of Wollongong

- Professor Jacqui Rammage has been re-elected to the University Council.

Appointments, departures and promotions

Australian National University

- Dr Jay Larson deaprted on 1 March 2015.
- Dr Viswananthan Puthan departed on 1 March 2015.

Macquarie University

New staff

- Professor Jim Denier has been appointed Head of Department of Mathematics, to commence on 1 October 2015.

  Jim holds a PhD from University of New South Wales and a BSc from the University of Melbourne.

  Jim spent his early career as a Research Fellow in the UK. He returned to Australia as a lecturer at University of New South Wales before taking up a position at the University of Adelaide.

Currently Jim is the Chair of Continuum Mechanics in the Department of Engineering Science at the University of Auckland. His research area is fluid mechanics.

Monash University

- Michael Brand has rejoined the Faculty of IT, as Associate Professor (Data Science).

New arrivals:

- Associate Professor Zihua Guo
- Dr Andrew Hammerlindl

Murdoch University

- Dr Vee Ming Ng has retired after 25 years at Murdoch University.
- Dr Nicola Armstrong has been appointed as Senior Lecturer. Her research area is the application of statistics to genomics.
- Dr Gerd Schroeder-Turk has been appointed as a Senior Lecturer. His research area is the geometry of materials and nanostructures.

University of Melbourne

New Research Fellow

- Dr Yuguang Fan

University of Newcastle

- Dr Bjorn Ruffer has joined as Lecturer in Applied Mathematics.

University of Southern Queensland

- Dr Enamul Kabir started in March 2015 as a lecturer in statistics.

University of Western Sydney

- Associate Professor Carmel Coady has retired after 26 years with UWS.
- Dr Roozbeh Hazrat has been promoted to Associate Professor.

University of Wollongong

- Simon Diffey has resigned.
- Daniel Tolhurst has been appointed as a research associate, working with Professor Brian Cullis.
- Emi Tanaka has joined as a post doctoral research fellow, working with Professor Brian Cullis.
- Dr Tran Vu Khahn has commenced a Vice Chancellor's Postdoctoral Fellowship. His research is in partial differential equations of several complex variables, particularly complex Monge–Ampere equations.

New Books

Deakin University

Batten, L., Li, G., Niu, W. and Warren, M. (eds) (2014). *Applications and Techniques in Information Security*. Proceedings of the 5th International Conference, ATIS 2014, Melbourne, November 26–28, 2014. (Communications in Computer and Information Science **490**). Springer. ISBN: 978-3-662-45669-9 (print), 978-3-662-45670-5 (online).

Conferences and Courses

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

Workshop on Mathematics and Computation

Date: Friday – Sunday 19–21 June 2015
Venue: CARMA, The University of Newcastle
Web: https://carma.newcastle.edu.au/meetings/

This three-day workshop is envisioned to include the following speakers: John Cannon, George Willis, Murray Elder, Jon Borwein, Matt Tam, Jeremy Avigad, Rob Lewis, Wadim Zudilin and Richard Brent.

Mathematics-for-industry New Zealand event

Date: 29 June – 3 July 2015
Venue: Institute of Natural and Mathematical Sciences, Massey University, Auckland
Web: minz.org.nz

A workshop to solve thought-provoking and industry-relevant challenges through mathematics is being held in New Zealand after a gap of nine years. This is in association with the longstanding ANZIAM Mathematics-in-Industry Study Group, which will be held at UniSA, Adelaide in 2016. You are invited to join an assembly of New Zealand's and Australia's brightest maths minds from 29 June to 3 July, at Massey University, Auckland, to work on solving complex questions. Attendance is free for participating mathematicians, together with all other mathematical scientists, and subsidies are expected for postgraduate students to attend. Teachers of mathematics are welcome as well. A number of New Zealand businesses, including Compac Sorting Equipment Ltd, will be involved and are now identifying the challenges they need solved.

Up to six core business problems will be presented to participating mathematicians by businesses. In these workshops, industrial organisations present problems from their own organisation and then subgroups are formed to develop solutions during the week, culminating in a review session on the final day. A plenary address will be given by a leading international industrial mathematical scientist. Publication of reports is encouraged for the ANZIAM *Journal of Applied Mathematics* (Series E).

The newly formed group Mathematics-in-Industry New Zealand (MINZ) is running the event, led by Australian and New Zealand Industrial and Applied Mathematics Group (ANZIAM) and Kiwi Innovation Network (KiwiNet), and is supported by Centre for Mathematics-in-Industry Massey University, AUT Mathematical Sciences Group, Te Punaha Matatini (the Complex Systems Centre) and Callaghan Innovation.

See the website for more details, and to register by 1 June 2015.

2015 AMSI Winter School on Algebra, Geometry & Physics

Date: 29 June to 10 July 2015
Venue: University of Queensland
Web: http://ws15.amsi.org.au

The school includes introductory and advanced courses in Geometric Representation Theory, Moonshine Conjectures and Vertex Operator Algebras, Moduli Spaces in Symplectic Geometry & K-Theory and its Applications. The 2015 School will be in collaboration with the ANU Special Theme Year. Registration is now open at the website, and closes on 21 June 2015.

The Mathematics of Conformal Field Theory

Date: 13–17 July
Venue: The Australian National University
Web: http://maths.anu.edu.au/events/mathematics-conformal-field-theory

This conference forms a part of the MSI's special year on Geometry and Physics and is a joint enterprise with the Pacific Institute for the Mathematical Sciences. The conference now officially has a website where all that wish to attend can register.

Talented Students' Day

Date: Wednesday 15 July 2015
Venue: Macquarie University
Web: https://www.mansw.nsw.edu.au/student-activities/talented-students-day/talented-students-day

Once again, the Mathematics Association of NSW will be holding its annual 'Talented Students Day' at Macquarie University on Wednesday 15 July 2015. This day is designed for Mathematics Extension 2 students in their Higher School Certificate year.

Industrial & Applied Mathematics Symposium 2015

Date: 16–17 July 2015
Venue: University of Wollongong
Web: http://eis.uow.edu.au/smas/anziam-symposium-2015/index.html

This two-day symposium will honour Jim Hill's 70th birthday, celebrating his contributions to Applied Mathematics. Registration is available at the website; there is no fee. Research topics to be presented include solid mechanics, fluid mechanics, financial mathematics, mathematical biology, nanomechanics and computational mathematics. Talks are by invitation, but if you would like to give a talk, please contact ngamta@uow.edu.au.

Baxter 2015: Exactly Solved Models & Beyond

Date: 19–25 July 2015
Venue: Palm Cove, Queensland
Web: http://baxter2015.anu.edu.au/

This international conference in honour of Rodney Baxter's 75th birthday is organised by the ANU College of Physical and Mathematical Sciences. For further details see the website, or *Gazette* 42 (1), p. 54.

International Workshop on Monte Carlo Methods for Spatial Stochastic Systems

Date: 21–23 July 2015
Venue: Emmanuelle College, The University of Queensland
Web: http://acems.smp.uq.edu.au/?page_id=18

The analysis of spatial data is of interest to many disciplines, including earth sciences, materials design, astronomy, robotics movement, and urban planning, to name but a few. Monte Carlo methods play an important role in the understanding of spatial stochastic systems, both from probabilistic and statistical points of view. The purpose of this international workshop is to bring together researchers and practitioners in spatial stochastic systems, with the aim of advancing the theory and application of Monte Carlo techniques for such systems.

Keynote speakers will be Gareth Roberts (University of Warwick, UK) and Adrian Baddeley (University of Western Australia).

We solicit talks on Monte Carlo techniques for spatial processes, including the following list of topics.

- Efficient algorithms for spatial process generation, including:
  - Spatial point processes
  - Random fields
  - Random tessellations
- Statistical inference of spatial data
- Rare events for spatial structures
- Random geometric graphs
- Randomized optimization for spatial structures

- Stereology and stochastic geometry
- Spatial models in statistical mechanics
- Particle methods.

Applications of spatial processes are also sought, both on a micro and macro scale.

- Cell biology
- Traffic systems
- Climate patterns
- Astronomy
- Materials design
- Mining

Registration is $290 for the three days and $150 for students.

For further details see the website or email acems.admin@uq.edu.au.

IGA/AMSI International workshop on Geometric Quantisation

Date: 27–31 July 2015
Venue: The University of Adelaide
Web: http://www.iga.adelaide.edu.au/workshops/July2015/

For further details and free registration, please see the website.

ICIAM 2015, the Eighth International Congress in Industrial and Applied Mathematics

Date: 10–14 August 2015
Venue: Beijing, China
Web: http://www.iciam2015.cn/

For more information, please see the website, or *Gazette* 41(3), p. 203.

Workshop in Honour of Brailey Sims

Date: Friday 21 August 2015
Venue: CARMA, The University of Newcastle
Web: https://carma.newcastle.edu.au/meetings/sims2015/

A one-day workshop in honour of Brailey Sims. The workshop will be followed by a reception and dinner in honour of Brailey Sims' retirement.

Confirmed external speakers include:

- Tim Dalby (Evans Head, NSW, retired)
- Chris Lennard (Pittsburgh)
- Warren Moors (Auckland)
- Aidan Sims (Wollongong)

Please contact Juliane Turner (Juliane.Turner@newcastle.edu.au, phone (02) 4921 5483, or facimile (02) 492 16898) if you have any questions.

Mathematics Education in a Connected World

Date: 16–21 September 2015
Venue: Grand Hotel Baia Verde, Catania, Italy

This is the 13th International Conference of The Mathematics Education for the Future Project. Please email Alan Rogerson at alan@cdnalma.poznan.pl for all details and updates.

Number Theory Down Under

Date: 18–19 September 2015
Venue: The University of Newcastle
Web: http://carma.newcastle.edu.au/meetings/ntdu3/

Please see the website for details and updates.

59th Annual Meeting of the Australian Mathematical Society

Date: 28 September to 1 October 2015
Venue: Flinders University
Web: www.austms2015.flinders.edu.au

Registration for Aust MS 2015 is now open on at the website (which should redirect to http://www.flinders.edu.au/science engineering/csem/research/centres/fmsl/austms2015/austms2015 home.cfm). We are lucky to have two Fields Medallists, Terry Tao and Manjul Bhargava, speaking at the meeting.

2015 Australian Conference on Science and Mathematics Education

Date: 30 September to 2 October 2015
Venue: Curtin University, Perth
Web: http://sydney.edu.au/iisme/conference/2015/index.shtml

International Workshops on Complex Systems and Networks

Date: 6–10 October 2015
Venue: University of Western Australia

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

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

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

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

KOZWaves 2015

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

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

39th Australasian Conference on Combinatorial Mathematics and Combinatorial Computing

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

See *Gazette* 42 (1) p. 56 or the website for further details, or email a Darryn Bryant at db@maths.uq.edu.au.

BioInfoSummer 2015

Date: 7 December 2015 to 11 December 2015
Venue: The University of Sydney
Website: http://bis14.amsi.org.au/bis-15/

Conference on Geometric and categorical representation theory

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

2016 AMSI Summer School

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

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

Travel Grant applications open: 13 August 2015.

Travel Grant applications and first registration close: 1 November 2015.

Final registration closes: 25 November 2015.

AMSI Big Day In

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

Mathematical Methods for Applications

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

This is a joint meeting of ANZIAM and ZAPA, the Zhejiang Applied Mathematics Association. For further information, please email P.Broadbridge@latrobe.edu.au.

Vale

Emanuel Strzelecki

With great regret, we inform members of the death of Emanuel Strzelecki, formerly of Monash University, a member of the Society for 50 years.

Kenneth Robert Pearson

With deep regret, we inform members that Professor Ken Pearson died on Monday 11 May. Ken's roles within the Society included a period as Deputy Editor of the Bulletin. Ken's former colleagues at La Trobe appreciated his contribution to the department, not only to mathematics but also to mathematical economics. An obituary will appear in a later issue.

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 2014 to 31 July 2015; stats; USN; Shelton Peiris
Dr Joel Andersson; Stockholm University; 1–31 October 2015; pure; USN; Leo Tzou
Jeremy Avigad; Carnegie Mellon University; May and June 2015; philosophy and mathematical sciences; UNC
Paul Baird; Laboratoire de Mathematiques, De Bretagne Atlantique; September to December 2015; UWA; Lyle Noakes
Dr Lihui Cen; Zhongnan University; April 2014 to April 2015; industrial optimization; CUT; Ph: 92663534
Thierry Coulhon; Paris Sciences et Lettres; 1 February to 31 December 2015; ANU; Peter Bouwknegt
Dr Heiko Dietrich; Monash University; 27 May to 5 June 2015; UWA; Michael Giudici
Michael Eastwood; 1 January to 31 December 2015; ANU; Thierry Coulhon
Dr Yi Fang; 31 March 2015 to 31 December 2015; ANU; Xu-Jia Wang

Gyorgy Feher; University of Amsterdam; 25 January to 26 June 2015; UMB; Jan de Gier

Prof Yasunori Fujikoshi; Hiroshima University; 12–19 September 2015; UWA; Berwin Turlach

Dr Ganes Ganesalingam; Massey University, NZ; 1 July 2014 to 30 June 2015; statistics; USN; Shelton Peiris

Mr Jacek Grela; Jagiellonian University, Poland; 15 March 2015 to 15 July 2015; UMB; Peter Forrester

A/Prof Xian-Jiu Huang; Nanchang University, China; 1 October 2014 to 30 September 2015; ANU; Xu-Jia Wang

Ingrid Irmer; Florida State University; 1 December 2014 to 30 June 2015; UMB; Craig Hodgson

Dr Zhong Jin; Shanghai Maritime University; August 2014 to August 2015; optimisation; FedUni; David Gao

A/Prof Istvan Kovacs; University of Primorska, Slovenia; 18 May to 10 June 2015; UWA; Michael Giudici

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

Guy Latouche; Universite libre de Bruxelles; 25 April to 7 May 2015; stochastic modelling; UAD; Giang Nguyen

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

A/Prof Xuesong Ma; Capital Normal University, China; 2 February to 1 July 2015; UMB; Sanming Zhou

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

David Mason; University of Witwatersrand; May to June 2015; UWA; Nev Fowkes

A/Prof Si Mei; Shanghai Jiaotong University, China; 9 August 2014 to 8 August 2015; pure; USN; Andrew Mathas

James McCoy; University of Wollongong; 1 January to 31 July 2015; ANU; Ben Andrews

A/Prof Sylvie Monniaux; Université Aix-Marseille; 15 October 2014 to 15 July 2015; ANU; Pierre Portal

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

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

Prof Somyot Plubtieng; Naresuan University, Thailand; June 2015; optimization; FedUni; Alex Kruger

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

Frederico Augusto Menezes Ribeiro; Universidade Federal de Minas Gerais; 9 March to 7 June 2015; UWA; Stephen Glasby

Dr Thidaporn Seangwattana; Naresuan University, Thailand; May to July 2015; optimization; FedUni; Alex Kruger

A/Prof Mei Si; Shanghai Jiaotong University; 28 August 2014 to 8 August 2015; pure; USN; Andrew Mathas

Paul Slevin; University of Glasgow; April to June; category theory and homological algebra; MQU; Richard Garner

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

Adam Sikora; Macquarie University; 1 January to 31 December 2015; ANU; Thierry Coulhon

Dr Doug Speed; University College London; 6 April to 27 May 2015; UMB; David Balding

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

Levent Tunçel; University of Waterloo; 1–21 September 2015; optimisation; RMIT; Vera Roshchina

Dr Ben Webster; 16 May to 29 June 2015; pure; USN; Anthony Henderson

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

A/Prof Dongsheng Wu; Michigan State University; 1 April to 10 June 2015; statistics; USN; Qiying Wang

Fuyi Xu; Shandong University of Technology; June 2014 to June 2015; applied mathematical modelling and boundary value problems; CUT; Ph: 92663534

Dr Fan Yang; Jiangsu University of Science and Technology, China; 1 October 2014 to 30 September 2015; UMB; Sanming Zhou

Jianfu Yang; Jiangxi Normal University, China; 15 May to 15 June 2015; nonlinear PDE; UNE; Shusen Yan

Prof Ahmet Yucesan; Suleyman Demirel University, Turkey; 30 May to 30 June 2015; UWA; Lyle Noakes

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

A/Prof Ke Zhu; Chinese Academy of Sciences; 6 April to 26 June 2015; statistics; USN; Qiying Wang

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Higher Education
Australian Mathematical Sciences Institute

AMSI Summer School 16

IN THE MATHEMATICAL SCIENCES

RMIT University

4-29 January 2016

AMSI | RMIT UNIVERSITY | Aust MS | ANZIAM

PRE-REGISTER TODAY: WWW.AMSI.ORG.AU/SS

Election of Officers and Ordinary Members of Council

Officers of Council

Nominations are invited for the following two Officers for the session commencing after the Annual General Meeting to be held in September 2015: one Vice-President and one President-Elect.

Note: According to Paragraph 34 (i) of the AustMS Constitution, after the AGM in September 2015, Professor T.R. Marchant will continue in office as the President, and Professor P.J. Forrester steps down as Immediate-Past-President, and is not eligible for immediate re-election as a Vice-President.

According to Paragraph 34 (ii), Associate Professor A. Henderson steps down as Elected Vice-President, and is not eligible for immediate re-election to that office.

According to Paragraph 34 (iii), the positions of Secretary and Treasurer will be appointed by Council at its September 2015 meeting.

The present Officers of the Society are:

President: T.R. Marchant
Immediate-Past-President: P.J. Forrester
Vice-President: A. Henderson
Vice-President (ANZIAM): L.K. Forbes
Secretary: P.J. Stacey
Treasurer: A. Howe

Ordinary Members of Council

The present elected Ordinary Members of Council are:

1. Members whose term of office expires after the AGM in September 2015
   J. Filar
   A. Glen
   D. Mallet
2. Members whose term of office expires after the AGM in September 2016
   S. Morrison
   J.G. Sumner
3. Members whose term of office expires after the AGM in December 2017
   J. de Gier
   H.S. Sidhu
   A. Sims

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, J. Filar, A. Glen and D. Mallet are not eligible for re-election at this time as Ordinary Members. Paragraph 35 of the Constitution requires that the elected Officers and elected members of Council shall include residents from all the States and the ACT. Accordingly, nominations for the two Officers and three Ordinary Members must include members from Queensland, South Australia and Western Australia, to satisfy this.

To comply with the Constitution (see Paragraphs 61 and 64), 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 19 June 2015*.

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

For the information of members, the following persons are presently *ex-officio* members of Council for the Session 2014–2015.

Vice President (Chair of ANZIAM):	L.K. Forbes
Vice President (Annual Conferences):	S.O. Warnaar
Incoming Vice President (Annual Conferences):	V. Gaitsgory
Representative of ANZIAM:	J. Piantadosi
Public Officer of AustMS and AMPAI:	P.J. Cossey
Chair, Standing Committee on Mathematics Education:	B.I. Loch
AustMS member elected to Steering Committee:	N. Joshi

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	A.J. Roberts (ANZIAM Journal Supplement)

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

The 2016 ANZIAM Medal: call for nominations

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

Closing date: 6 November 2015.

Nominations for the Award can be made by any member of ANZIAM other than the nominee. A nomination should consist of a brief CV of the nominee together with the nominee's list of publications and a one-page resume of the significance of the nominee's work. Nominations should be forwarded in confidence, electronically, to the Chair of the Selection Panel, Professor Robert McKibbin, email: R.McKibbin@massey.ac.nz.

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

The 2016 J.H. Michell Medal: call for nominations

Nominations are now sought for the J.H. Michell Medal, an award given in honour of John Henry Michell, by ANZIAM, a division of the Australian Mathematical Society. The award is for outstanding new researchers in applied and/or industrial mathematics.

Closing date: 6 November 2015.

Nominations for the Award can be made by any member of ANZIAM other than the nominee. A nomination should consist of a brief CV of the nominee together with the nominee's list of publications a one-page resume of the significance of the nominee's work. Nominations should be forwarded in confidence, electronically, to the Chair of the Selection Panel, Associate Professor Harvinder Sidhu, email: h.sidhu@adfa.edu.au.

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

AustMS support for Special Interest Meetings

Applications are now considered twice a year, at the start of June and the start of December. For 2015, closing dates are 5 June and 26 November.

If funding is being sought from both AustMS and AMSI, a single application should be made at http://www.amsi.org.au/component/content/article/881.

If funding is not being sought from AMSI, please use the application form available at http://www.austms.org.au/Special+Interest+Meetings and send it to the secretary at Secretary@austms.org.au.

AustMS Accreditation

Mr Kurt Pudniks of Nova Systems has been accredited as a Graduate Member (GAustMS).

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

Professor Alan Carey of the Australian National University
Professor Norman Dancer of the University of Sydney
Professor Robert Dewar of the Australian National University
Professor Roger Grimshaw of the University of Loughborough

Professor John Hutchinson of the Australian National University
Professor Nalini Joshi of the University of Sydney
Associate Professor James McCoy of the University of Wollongong
Professor Colin Thompson of the University of Melbourne
Professor Ole Warnaar of the University of Queensland
Professor Alan Welsh of the Australian National University.

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.

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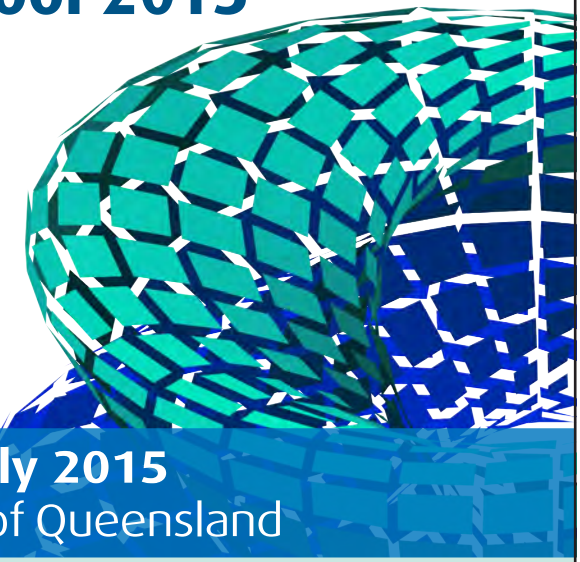

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Membership and Correspondence

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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The Journal of the Australian Mathematical Society

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School of Mathematical and Physical Sciences
University of Newcastle, NSW 2308, Australia

The ANZIAM Journal

Editor: Professor A.P. Bassom
School of Mathematics and Statistics
The University of Western Australia, WA 6009, Australia

Editor: Associate Professor G.C. Hocking
School of Chemical and Mathematical Sciences
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Bulletin of the Australian Mathematical Society

Editor: Professor John Loxton
University of Western Sydney, Penrith, NSW 2751, Australia

The *Bulletin of the Australian Mathematical Society* aims at quick publication of original research in all branches of mathematics. Two volumes of three numbers are published annually.

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