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The Australian Mathematical Society

Gazette

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- 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
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Volume 35 Number 4 2008

Editorial

Welcome to the September issue of the *Gazette*.

In Maths Matters, Australia's only Fields Medalist, Terry Tao, writes about the state of mathematics in Australia. Despite his busy schedule, Terry ran a petition for mathematics at the University of Southern Queensland, which attracted more than a thousand signatures from mathematicians around the world, including leaders in industry and education and even a Nobel laureate. He discusses the response to this crisis, and how to approach and hopefully avert future crises.

Peter Hall's president's column explains the Society's response to the new ERA journal rankings by the ARC which may have a negative effect on the mathematical community. This issue also contains the outcomes of the mathematical sciences questionnaire, a questionnaire sent to Heads of Mathematical Sciences at Australian universities to identify if the National Strategic Review of Mathematical Sciences Research in Australia conducted in 2006 and additional government funding for mathematical sciences in 2007 have improved the situation in universities. Sadly, it appears that this is not the case.

On a happier note, Norman Do has marked submissions and our congratulations go to Jamie Simpson for winning the book voucher for his solutions to Puzzle Corner 7. Bill Blyth reports on this year's Access Grid Retreat in Vancouver in what may become a regular column about the Access Grid and its use in collaborative mathematics teaching across the nation. We also have reports from the ANZIAM 2008 conference, and MISG 2008, along with two new technical papers, two book reviews and all the news from the Australian mathematical community.

If you would like to contribute to the *Gazette* we would be very happy to hear from you. We are always interested in hearing from potential authors for our occasional columns Maths@Work on mathematics outside of academia, and Classroom Notes, on innovations in maths teaching. You can also submit communications, technical papers, and we have a number of books available for review — details can be found on the *Gazette* website at http://www.austms.org.au/gazette.

Happy reading from the *Gazette* team.

President's column

Peter Hall*

Journal Ranking and ERA

The issue of journal ranking is the main one exercising everyone's minds at present. It is such a large and serious issue that it almost eliminates all others from contention. However, a related matter is the Australian Reserach Council's (ARC) misallocation of mathematical physics to physics, rather than mathematics, among the clusters it established in the run-up to ERA (Excellence in Research for Australia). We have protested about this, and have received the following response from the ARC:

> Thank you for your suggestion regarding the placement of "Mathematical Physics" within the Physical Sciences cluster. You are correct that this is not in accordance with the ANZSRC. The ARC will take this into account when consolidating feedback.

Although I'm not one to declare confidence in the ARC doing the right thing (they usually try all the other options first), I'm optimistic that they will see the light in the matter of mathematical physics.

However, the journal ranking issue is more of a challenge. The problems we are facing seem to be caused primarily by two aspects of the ARC's methodology:

(i) a substantial reduction in the total number of journals that the ARC will allow us to rank (they have correspondingly reduced the number of journals we can place into bands A* and A); and
(ii) the use of impact factors to rank journals in applied mathematics and statistics, and perhaps also mathematical physics.

So that we can be clear what is what, I should mention here that the previous journal ranking was undertaken by the National Committee for the Mathematical Sciences (NCMS), whereas the current ranking was prepared by the ARC. It's with the ARC list that we presently have serious problems.

Regarding the number of research outlets that the ARC is currently willing to regard as mathematical science journals, let me try to give you a sense of the scale of the changes that the ARC has made. According to my calculations, the ARC list of ranked journals allocates 538 journals to pure mathematics, 211 journals to applied mathematics, 28 journals to mathematical physics, and 169 journals to statistics (including probability), making a total of 946 journals for the mathematical sciences. However, the list produced by the NCMS allocated a total of 1369 journals to the mathematical sciences. That is 45% more than the ARC list. On this basis, and making some assumptions about uniformity of distribution

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among the four research areas, we should expect the ARC's list to contain only two-thirds the number of journals in tiers A*, A and B as the NCMS list.

Indeed, both the ARC and NCMS lists are restricted to having 5% of journals in tier A* and 15% in tier A, so by reducing the total number of journals we are forced to have fewer journals in the A* and A categories. I should mention too that there are a number of other inaccuracies in the ARC's allocation of journals to areas. To give just a few examples, a journal in statistical mechanics is erroneously included under statistics, a statistics journal has been mistakenly allocated to applied mathematics, and some journals have been given very unexpected rankings by the ARC.

A large number of journals have disappeared entirely from the NCMS list, appearing nowhere on the ARC list. (In my field, the journals *Bioinformatics* and *Biostatistics* are extraordinary omissions.) One reason for this (although not one that applies in the above two cases) may be that some of the ARC's advisors have an aversion to journals that are not covered by the on-line citation index, the Web of Science (usually accessed through the Web of Knowledge). Another major reason for the reduction in the number of journals on the ARC list has been the ARC's resistance to listing, in two or more different categories (or, equivalently, against two or more four-digit field-of-research codes), the journals where mathematicians publish. For example, a journal where mathematicians publish their work in mathematical biology, and which is classified as a biological sciences journal, might be ranked lowly by biologists but highly by mathematicians, but will have to keep the low ranking as far as mathematics is concerned. In the NCMS list a journal could be ranked differently by the two groups.

We have let the ARC know that we are unhappy with this. Apart from reducing the number of journals we can have, and therefore also the number of journals we can have in the A* and A categories, the disallowance of dual rankings strongly inhibits multidisciplinary work in the mathematical sciences. In response, the ARC stated that one of the concerns guiding their development of the new ranking was that, in the case of the NCMS list, 'it was found that the mathematics listing was far too broad, and included hundreds of journals that were not core to mathematics'.

Additionally, the Australian Academy of Science has told me by email that the ARC had expressed to them the following concerns about the original list: 'The sub-discipline lists were lumped into one list and a large number of journals core to other disciplines were added'. The first of these complaints means that the NCMS list didn't draw divisions among pure maths, applied maths, mathematical physics and statistics. That problem could have been fixed very easily. The second complaint is the one I mentioned earlier — that journals that are 'not core to mathematics' were included by the NCMS in their list.

Nevertheless, in some pairs of fields distinguished by four-digit FoR codes, although seldom in mathematics, journals were given dual rankings in the ARC list. We have invoked that precedent to try to persuade the ARC to allow dual rankings for journals that we regarded as of fundamental importance to mathematics and statistics, but which are also claimed by other areas. More generally, we have argued that mathematics and statistics, uniquely among the sciences, cut across

many discipline areas in science and social science. The fact that mathematicians and statisticians publish in many non-mathematics journals should be seen as a strength, not a weakness, especially in an age where first-rate work in science and technology is increasingly multidisciplinary. Therefore dual ranking should be encouraged.

The ARC's use of citation-based journal-ranking methodology is also of serious concern. According to the ARC, the pure mathematics list was prepared with outside assistance. However, it seems clear that the applied mathematics and statistics/probability lists were prepared largely from citation data, and that no experts in those fields were consulted directly by the ARC. An email message sent to me from the ARC in June mentioned that 'citation data was used to derive the applied mathematics and statistics journal rankings'.

The ARC knows that we have previously protested the use of impact factors to rank journals. Apparently in conscious response to that view, they stated in an email message to me: 'It is worth noting that journal impact factors were not used [for applied mathematics and statistics journal ranking], but rather a calculation of the average citation rate of papers in a journal over a five year period was employed'. To me, this means that the ARC used five-year impact factor data, so I was hardly mollified by their revelation. I'm concerned that the ARC neither knows what an impact factor is nor that its use holds many dangers in the context of the mathematical sciences.

In particular, in a submission to the ARC on the subject of the ERA consultation paper, including journal ranking, the Society made the following points:

> Members of the mathematical sciences community, including myself, are deeply troubled by the ARC's recently released journal ranking. We feel that, if it is allowed to stand and is used as part of a program to assess research performance, the ARC journal ranking will seriously damage mathematics and statistics in Australia. The shortcomings of the ranking are too numerous to itemise here, but the National Committee for the Mathematical Sciences will make a separate submission on this subject.
>
> More generally, the international community of mathematical scientists has expressed significant concern about the use of citation data to infer journal rankings, or to determine the performance of mathematical scientists. In particular, the Institute of Mathematical Statistics, the International Council on Industrial and Applied Mathematics, and the International Mathematical Union have recently produced a joint report addressing the shortcomings of citation analyses.

(You can find the report in issue 35(3) of the *Gazette*.)

The Australian Mathematical Society contacted the Statistical Society of Australia and ANZIAM to see whether they would support approaches to the IMS and ICIAM, respectively, seeking their involvement in this issue. William Dunsmuir, President of the Statistical Society, quickly gave me his support, and just as promptly Phil Howlett agreed to take up within ANZIAM the issue of approaching ICIAM. The Australian Mathematical Society wrote to the IMS President, Jianqing Fan, who quickly sent a very helpful letter which the Society passed

on to the ARC with a letter of its own. This precipitated a rapid response from the ARC: The ARC CEO, Margaret Sheil, asked to meet me in Melbourne the following day. I was unable to attend the meeting, so I contacted Hyam Rubinstein, the Chair of the NCMS. He and Peter Taylor arranged to meet Professor Sheil that afternoon.

The meeting was very successful. It took place on 2 July, and two days later Professor Sheil sent the NCMS a letter which captured the main issues on which agreement was reached. Let me quote from that letter here, so that it is clear what has been achieved: (1) 'I would like to accept the National Committee's offer to review the journal list'. (2) 'I would also like to agree on the timeframe ... We would ask that all of NCMS's work to develop a revised journal list be completed by 14 August 2008'. (3) 'It is important that the NCMS's review includes engagement and feedback from the greater mathematics research community'. (4) The NCMS should 'add any peer reviewed journals and their requested ranking'. (5) The NCMS should 'revise rankings of existing journals that are currently in the list'. (6) Suggestions from the NCMS should be conveyed to the ARC using the standard form distributed to universities for their submissions.

Point (1) above clearly gives the green light to the NCMS to revise the ARC's ranking. In her letter Professor Sheil notes that 'the ARC will need to consider NCMS's input as a recommendation to be considered alongside feedback from the sector ...' This seems to make it clear that the ARC is willing to consider the NCMS recommendation in its own right, and that the ARC does not expect that recommendation to come to it as part of the general 'feedback from the sector'.

The Society has written to the IMS to thank them for their support, and to Professor Sheil to thank her for her willingness to accommodate the mathematical sciences community's perspective in the matter of journal ranking.

In addition to the Society's submission to the ARC, Phil Howlett has made an excellent submission on behalf of ANZIAM, pointing out that the ARC ranking was seriously deficient in the area of applied mathematics. His letter was particularly authoritative, and gave details of errors that were committed in the applied mathematics ranking. ANZIAM's active support in this issue is greatly appreciated.

In conclusion, I'd like to pay tribute to the very substantial, effective and energetic role that Hyam Rubinstein is playing in our efforts to revise the ARC rankings. Some of you will recall that, to produce the NCMS rankings last year, Hyam put together four subcommittees representing pure mathematics, applied mathematics, mathematical physics, and statistics and probability, respectively. When the ARC rankings were released, and I discovered that there were serious problems with them, I contacted Hyam and asked him to recall the subcommittees. He quickly agreed to do that, and has put a great deal of energy into the task of challenging the ARC's rankings. We all owe Hyam a substantial debt for his efforts.

I would also like to acknowledge the significant assistance provided by Jim Denier, who painstakingly compiled a comparison of the NCMS and ARC rankings. That must have been a very challenging task, and the results of Jim's work are also proving invaluable to our efforts.

Mathematics in Australia

Terence Tao*

On 17 March 2008, the University of Southern Queensland (USQ) at Toowoomba announced proposals [1] to cut staff at the Department of Mathematics and Computing [2] (which consists of the disciplines of mathematics, statistics, and computing) by almost 50%, eliminate all non-service teaching classes from the mathematics curriculum, and also eliminate the mathematics, statistics, physics, and chemistry majors at USQ. These proposals were part of their rationalisation program entitled *Realising our Potential* [3]. This program was not initiated in response to any immediate financial crisis at USQ — the university recently reported a doubling in its annual profit [4], to $10.3 million — but out of a desire to significantly change the spending profile of the university, in particular to reduce the proportion of university expenditure going towards staff. The staff reductions in each department were not to be based on research performance, teaching, or service, but were instead to be determined on purely by the student enrolments in the majors of that department.

The Department of Mathematics and Computing bore a disproportionately high share of the burden of staff cuts in the initial proposal, despite holding steady in its enrolments, with a strong record of research and teaching excellence, and earning a significant profit for the university (especially when counting the roughly $1.2 million annually in additional federal support to USQ associated to student enrolments in mathematics). For instance, of the 15 net positions to be cut from the Faculty of Science, 12 were to come from this department, and eight in particular from the 14 staff in the divisions of mathematics and statistics. (Several other departments with much smaller enrolments were designated as 'initiatives' and spared the worst of the cuts, and even received increased allocations in some cases.)

Staff cuts, particularly in mathematics and the 'hard' sciences, are unfortunately an all too common occurrence these days in Australia, as well as overseas. But the cuts at USQ were particularly severe, and would have severely impacted maths education and training in the region, as discussed by Peter Hall in the President's Column in the previous issue of the *Gazette* [5]. Initial correspondence with the USQ administration on these matters did not get very far, and so at the beginning

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of April, I and several other Australian mathematicians launched an online campaign, at http://terrytao.wordpress.com/support-usq-maths/, to urge the USQ administration to work with the department to retain its mathematics training and education capability as much as possible.

The support garnered by these efforts was remarkably strong and broad; for instance, of the thousand or so signatures collected on the online petition, the Australian mathematics community was joined by overseas mathematicians, as well as leaders in industry and education in Australia, university administrators, students and their parents, and even a Nobel Laureate. The petition can be found online at http://terrytao.wordpress.com/about/petition-to-support-maths-statistics-and-computing-at-usq/; the many thoughtful and impassioned comments left there in support of the petition are well worth reading. Beyond the online campaign, there was also a significant amount of sympathetic local and national newspaper and radio coverage, as well as the strong support of the local MP for USQ's Toowoomba South district, the International Mathematical Union, the National Tertiary Education Union, the local mathematics teachers associations, the Statistical Society of Australia Inc., and many other institutions. (Their letters of support can be found on the campaign page listed above [6].)

In response to this local, national, and international pressure, and about a month after the beginning of the online campaign, the administration did revise its initial proposals, finding additional financial resources to soften (though not eliminate) the impact of the cuts to mathematics and statistics; in particular, the eight staff cuts in these divisions were reduced to three (which have since been realised through voluntary redundancy packages), and the maths major was to be reviewed for 'viability', rather than to be eliminated immediately. The proposal still had significant negative aspects, in particular demanding an unusually high teaching workload and staff:student ratio for the remaining staff in the department, and mathematics at USQ has still become weaker than it was before the cuts were proposed, but the outcome is still an improvement over the original restructuring plan.

What lessons are to be drawn from this experience? On the one hand, I would say that there are some unexpected reservoirs of support for higher mathematics in the wider community, particularly with regard to its role in mathematics education and in providing key skills to industry. For instance, spurred by many calls from constituents on this issue, the local MP for Toowoomba South, Mike Horan, spoke in the Queensland Parliament on April 17 concerning the original proposal [8]:

> ... I believe in putting forward this draft proposal [USQ] has made a major mistake in making the cutbacks to mathematics and statistics ... If there is one thing of concern to our nation today, it is the lack of mathematicians in universities and to provide teaching in our high schools as basis for science courses and to meet the challenges that are coming in terms of new technology systems, climate change, changes in demographics, changes in computer systems and so forth ...
>
> The people who spoke to me were teachers, academics, high school students, and many concerned people in Toowoomba. This is a draft proposal. I would

> ask the university to overturn it, particularly in the subjects of mathematics and statistics ...

I personally also received many offers of assistance from mathematicians, mathematics organisations and other individuals across the world, many of whom wrote on their own initiative to the USQ administration or to local government officials; at every mathematics conference I attended, I was asked on the latest news on USQ and on the state of mathematics in Australia. One common sentiment in these conversations was that it was important to stand up and fight these sorts of battles wherever they occur, as a matter of principle as well as for the stake in the immediate outcome; there are all too many stories in many countries of higher education in the mathematics and the sciences being eroded due to a real or perceived lack of a strong defense by the academic community.

On the other hand, it seems that community support, while extremely valuable, is not by itself sufficient to prevent unwise decisions by university administrations, or to coherently make a strong case for the need and value of higher mathematics in Australia. For this, an organised and sustained long-term effort at many levels is needed. The USQ campaign managed to achieve a remarkable amount in the month or so that it lasted, but it would have perhaps have been even more effective had it been initiated earlier, so that one had more time to communicate the message and to coordinate efforts more with the broader science and education community and with the USQ maths department and other local stakeholders.

The mathematics organisations in Australia, such as the Australian Mathematical Society and the Australian Mathematical Sciences Institute, already do a lot of fine work behind the scenes in collecting accurate information on the state of mathematics in Australia, and reporting this information and their recommendations to state and federal governments and the media, as well as to the *Gazette* of course. But it seems that more could be done to raise broader awareness of the many issues facing Australian mathematics today, ranging from the need to provide mathematical and statistical skills to the workforce, to standards for mathematics education in schools, to the need to recognise and support research and teaching excellence, or to encourage more students to acquire mathematics literacy or higher mathematical skills. As one experimental step in this direction, Philip Broadbridge, Peter Hall, Birgit Loch and I have launched a new blog, at http://austmaths.wordpress.com, dedicated to reporting on and discussing these sorts of issues, as well as anticipating (and hopefully, averting) any future crises that may arise. More generally, given the support for mathematics present at many (though, unfortunately, not all) levels in Australia, one can hope to reverse the slow declines in higher mathematics that have occurred at universities across the country in recent years; but it is likely to require a sustained amount of attention, effort, and outreach to accomplish this.

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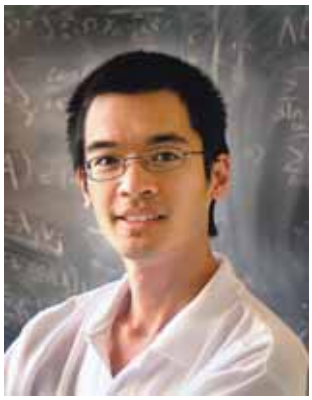

Terence Tao was born in Adelaide, Australia in 1975. He has been a professor of mathematics at UCLA since 1999, having completed his PhD under Elias Stein at Princeton in 1996. Tao's areas of research include harmonic analysis, PDE, combinatorics and number theory. He has received a number of awards, including the Salem Prize in 2000, the Bochner Prize in 2002, the Fields Medal and SASTRA Ramanujan Prize in 2006, the MacArthur Fellowship and Ostrowski Prize in 2007, and the Waterman Award in 2008. Terence also currently holds the James and Carol Collins chair in mathematics at UCLA, and is a Fellow of the Royal Society, the Australian Academy of Sciences (Corresponding Member), and the National Academy of Sciences (Foreign member).

Puzzle corner

Norman Do*

Welcome to the Australian Mathematical Society *Gazette*'s Puzzle Corner. Each issue will include a handful of entertaining puzzles for adventurous readers to try. The puzzles cover a range of difficulties, come from a variety of topics, and require a minimum of mathematical prerequisites to be solved. And should you happen to be ingenious enough to solve one of them, then the first thing you should do is send your solution to us.

In 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 e-mail solutions to N.Do@ms.unimelb.edu.au or send paper entries to: Gazette of the AustMS, Birgit Loch, Department of Mathematics and Computing, University of Southern Queensland, Toowoomba, Qld 4350, Australia.

The deadline for submission of solutions for Puzzle Corner 9 is 1 November 2008. The solutions to Puzzle Corner 9 will appear in Puzzle Corner 11 in the March 2009 issue of the *Gazette*.

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Lucky lottery

Fifty players take part in a lottery in which they must write down the numbers from 1 up to 50 in some order. Fifty balls, numbered from 1 up to 50, are drawn one by one from a barrel to provide the winning sequence. The players compare this to their own sequences and earn one dollar for each number which matches. Furthermore, the jackpot is awarded to any player who is lucky enough to have the winning sequence itself. Given that each player wins a different amount of money, prove that at least one of them must have won the jackpot.

Ultramagic square

A 9×9 grid is filled with the numbers from 1 up to 81. If the product of the numbers in the kth row is equal to the product of the numbers in the kth column for all k, then we say that the square is *ultramagic*. Does there exist an ultramagic square?

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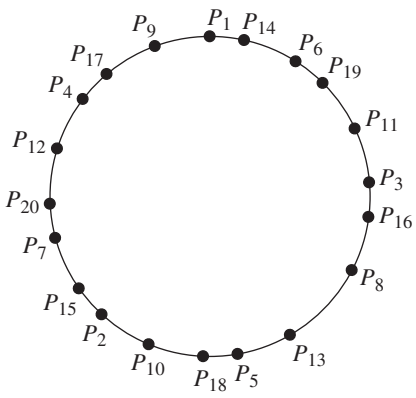
Cakes and boxes

A triangular cake and a triangular box are congruent, but are mirror images of each other. We would like to cut the cake into two pieces which can fit together in the box without turning either piece over.

(a) Show that this is possible if one angle of the triangle is three times as large as another.
(b) Show that this is possible if one angle of the triangle is obtuse and twice as large as another.



Golden circle

Let P_1 be a point on a circle whose circumference is equal to the golden ratio $\phi = (1+\sqrt{5})/2$. Let P_2 be the point on the circle which is one unit of arc length along from P_1 in the clockwise direction. Let P_3 be the point on the circle which is one unit of arc length along from P_2 in the clockwise direction, and so on. Suppose that you mark the points $P_1, P_2, \ldots, P_n$ for some positive integer n. Prove that if P_i and P_j are adjacent marked points on the circle, then $|i-j|$ is a Fibonacci number.

Robots in mazes

A maze is an 8×8 chessboard with walls along the four sides and between some pairs of adjacent squares. A robot trapped in the maze can walk from one square to an adjacent one as long as there is no wall between them. If the robot can visit every square on the chessboard from some initial position, then the maze is called *good* and otherwise, it is called *bad*.

1. Are there more good mazes or bad mazes?

A *proper* maze is a good maze which has one square marked START and another one marked FINISH. A *program* for the robot is a finite sequence of moves: UP, DOWN, LEFT or RIGHT. A robot will move to the adjacent square in the given direction unless there is a wall blocking it, in which case, it remains on the same square.

2. Suppose that the robot begins on the square marked START. Does there exist a program which will eventually lead the robot to the square marked FINISH, no matter which proper maze is given?

Solutions to Puzzle Corner 7

The $50 book voucher for the best submission to Puzzle Corner 7 is awarded to Jamie Simpson.

Physicists and chemists

Solution by Warren Brisley: Each mathematician has a liar to their left, so there are at least N liars. However, each physicist has a truth-teller to their left, so there are at least N truth-tellers. There are $2N$ people seated around the table, so there must be precisely N liars and N truth-tellers. Since the number of liars among the mathematicians and the number of liars among the physicists are equal, N must be even.

Sums of alternating sums

Solution by Tony Watts: Consider any subset $X \subseteq \{1, 2, \ldots, n\}$ which does not include n as an element and suppose that its alternating sum is s. Now consider the subset $X' = X \cup \{n\}$ with alternating sum s'. Note that, in the expressions for the alternating sums of X and X', all numbers apart from n will appear with opposite signs. Since n appears with a positive sign in the expression for the alternating sum of X', it follows that $s + s' = n$.

The 2^n subsets of $\{1, 2, \ldots, n\}$ consist of 2^{n-1} which do not include n as an element and 2^{n-1} which do include n as an element. Furthermore, they form 2^{n-1} pairs (X, X') whose sum of alternating sums is precisely n. Hence, the sum of the alternating sums over all subsets of $\{1, 2, \ldots, n\}$ is $n2^{n-1}$.

Rational or irrational?

Solution by David Angell: If A_k was rational, then it would have an eventually periodic decimal expansion. But it is clear that A_k contains arbitrarily long strings of zeros, because 10^{nk} appears in the decimal expansion of A_k for every positive integer n. So the decimal expansion would consist entirely of zeros from some point onwards. Since this is not the case, there is no value of k for which A_k is rational.

David also points out that this is a special case of the following theorem of Kurt Mahler:

> *Let f be a non-constant polynomial with rational coefficients such that $f(k)$ is a positive integer for all positive integers k. Let A be the real number between 0 and 1 formed by writing $f(1), f(2), f(3), \ldots$ in order after the decimal point. Then A is transcendental and not a Liouville number.*

Polygons and rectangles

Solution by Dave Johnson: Given a convex polygon $\mathcal{P}$ of area 1, let A and C be points of $\mathcal{P}$ whose distance is maximal. Let a and c be the lines through A and

C, respectively, perpendicular to AC. Now let B and D be points of $\mathcal{P}$, one on each side of AC and at maximal distance from it. Let b and d be the lines through B and D, respectively, parallel to AC. Denote the quadrilateral $ABCD$ by $\mathcal{Q}$ and the rectangle bounded by the lines a, b, c, d by $\mathcal{R}$. The maximality conditions and the convexity of $\mathcal{P}$ ensure that $\mathcal{Q} \subseteq \mathcal{P} \subseteq \mathcal{R}$ and, by construction, we have $\text{area}(\mathcal{Q}) = \frac{1}{2}\text{area}(\mathcal{R})$. Finally, we conclude that

$$\text{area}(\mathcal{R}) = 2 \times \text{area}(\mathcal{Q}) \leq 2 \times \text{area}(\mathcal{P}) = 2.$$

We note that this proof works for any plane convex set $\mathcal{P}$ of area 1. Furthermore, the constant 2 cannot be replaced by a smaller number, as evidenced by taking $\mathcal{P}$ to be the isosceles right-angled triangle with hypotenuse of length 2.

The broken calculator

Solution by Jamie Simpson: We will prove the stronger result that every number of the form $\sqrt{p/q}$, where p and q are relatively prime positive integers, can be produced on the calculator. The proof will proceed by induction on $p + q$.

Since $\cos 0 = \sqrt{1/1}$, the statement holds when $p + q = 2$. Now suppose that it holds for all $p + q < n$ and consider $\sqrt{a/b}$ where $a + b = n$. Note that

$$\tan \circ \cos^{-1} \circ \sin \circ \tan^{-1} \sqrt{a/b} = \tan \circ \cos^{-1} \sqrt{a/(a+b)} = \sqrt{b/a}.$$

So we may assume, without loss of generality, that $b > a$. By the induction hypothesis, we can produce $\sqrt{a/(b-a)}$ on the calculator so we can also produce the number

$$\sin \circ \tan^{-1} \sqrt{a/(b-a)} = \sqrt{a/b}.$$

The desired result now follows by induction.

Chessboard puzzles

Solution based on work submitted by Gerry Myerson:

(1) First, we prove the following lemma: if $ABCD$ is any square and P a point in the plane of the square, then $PA^2 + PC^2 = PB^2 + PD^2$. After translation, rotation and dilation, we can assume that $ABCD$ is the unit square in the first quadrant of the Cartesian plane. So if $P = (x, y)$, then one side of the equation is $[x^2 + y^2] + [(x-1)^2 + (y-1)^2]$ and the other is $[x^2 + (y-1)^2] + [(x-1)^2 + y^2]$, both of which are equal.
Now consider the chessboard divided into sixteen 2×2 blocks in the natural way. Such a block consists of four unit squares, with two diagonally opposite ones black and the other two white. Therefore, the result follows by applying the above lemma on the centres of these four squares and summing up over the sixteen 2×2 blocks.

(2) The smallest possible score is 9 which can be achieved by labelling the squares 1 to 8 across the top row, 9 to 16 across the second row, and so on, down to 57 to 64 along the bottom row. To see that it is impossible to do better, note that one can travel from the square labelled 1 to the square labelled

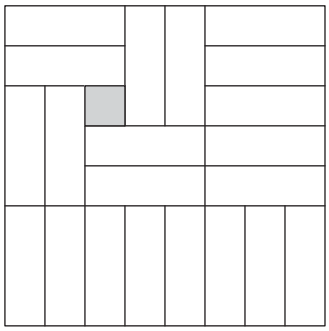
64 in at most 7 king moves. In particular, there is a path from one to the other which passes through two squares which share a common side or vertex whose labels have a difference of at least $(64-1)/7 = 9$.

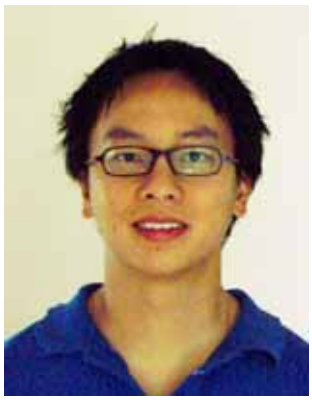
(3) Consider labelling the squares of the chessboard in the following two ways.

1	2	3	1	2	3	1	2
2	3	1	2	3	1	2	3
3	1	2	3	1	2	3	1
1	2	3	1	2	3	1	2
2	3	1	2	3	1	2	3
3	1	2	3	1	2	3	1
1	2	3	1	2	3	1	2
2	3	1	2	3	1	2	3

2	3	1	2	3	1	2	3
1	2	3	1	2	3	1	2
3	1	2	3	1	2	3	1
2	3	1	2	3	1	2	3
1	2	3	1	2	3	1	2
3	1	2	3	1	2	3	1
2	3	1	2	3	1	2	3
1	2	3	1	2	3	1	2

In either case, the placement of a 3×1 rectangle will cover one square of each label. In both diagrams, there are 21 squares labelled 1, 22 squares labelled 2 and 21 squares labelled 3. It follows that the 1×1 square must be placed on one of the squares which is labelled 2 in both diagrams. Therefore, the 1×1 square must be placed on one of the four shaded squares. In this case, the tiling is given by the following diagram and its rotations.





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Communications

On the form of an odd perfect number

Tim S. Roberts*

It has been known since the time of Euler that an odd perfect number N (if it exists) must have the form $N = p^a Q^2$ where p is prime and $p = a = 1 \bmod 4$ (see, e.g., [1, pp. 3–33]). Further, it has been shown that N must equal $1 \bmod 12$, or $9 \bmod 36$ [3], [2]. However, we can do a little better than this.

From either result it is immediately evident that if 3 divides N, then 3^k divides N, where $k = 0 \bmod 2$.

If $k = 0$, then N must be of the form $1 \bmod 12$.

For any positive integer $N = p_1^{k1} p_2^{k2} \dots p_n^{kn}$, the sum S of all of the divisors (including 1 and N itself), is given by

$$S = (1 + p_1^1 + p_1^2 + \dots p_1^{k1})(1 + p_2^1 + p_2^2 + \dots p_2^{k2}) \dots (1 + p_n^1 + p_n^2 + \dots p_n^{kn}) .$$

If N is perfect, it is equal to the sum of its divisors (excepting itself), so $N = S - N$, so $2N = S$. Thus, if N is perfect, and a factor of N is 3^k, then N is itself divisible by $(1 + 3^1 + 3^2 + \dots + 3^k)$.

If $k = 2$, then N must be of the form $9 \bmod 36$. Further, since N is perfect, from the above we know that $3^0 + 3^1 + 3^2 = 1 + 3 + 9 = 13$ must divide $2N$, and hence $N = 0 \bmod 13$. Thus, N must satisfy both $N = 9 \bmod 36$ and $N = 0 \bmod 13$. From the Chinese remainder theorem, we can deduce that N must equal $117 \bmod 468$.

If $k > 2$, then N is divisible by $3^4 = 81$. Thus, N must satisfy both $N = 9 \bmod 36$ and $N = 0 \bmod 81$. From the Chinese remainder theorem, we can deduce that N must equal $81 \bmod 324$.

Thus, if N is an odd perfect number, it must be of the form $N = 1 \bmod 12$ or $N = 117 \bmod 468$ or $N = 81 \bmod 324$.

Of course, it is possible to further refine the last of these results in a similar way, by considering separately values of k greater than or equal to 4.

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Review of mathematics in Go8 universities

Hyam Rubinstein*

At a meeting on 3 July, the Group of Eight (GO8) universities agreed to a review of mathematics, to be undertaken by Professor Gavin Brown, recently retired vice-chancellor of Sydney University.

Since that meeting, Dennis Trewin (retired Chief Statistician, Australian Bureau of Statistics), Peter Dowd (Dean of Science at University of Adelaide and a geostatistician), Nalini Joshi, William Dunsmuir, Peter Hall, Hyam Rubinstein and Philip Broadbridge have all agreed to be members of the Reference Committee for this review.

Go8 Review of Mathematics: terms of reference

1. Investigate and report on the present state of mathematics teaching and research in Go8 universities.
2. Report on the future demand for mathematicians in Australia, and the capacity of mathematics departments in Go8 universities to substantially meet that demand. This aspect is to cover pure and applied mathematics, statistics, and the range of disciplines which require substantial university-level mathematics.
3. Make recommendations on options to encourage more students to study mathematics at university.
4. Identify possible options for Commonwealth and/or state government action to support strengthening of mathematics education in Australia.
5. Identify existing barriers and ways of attracting mathematics educators at secondary and university level to migrate to Australia, to strengthen mathematics education.

We hope that this will be an opportunity to make the case for rebuilding Australian mathematics and statistics, after the decline of the past decade.

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Mathematical sciences questionnaire report

Hyam Rubinstein*, Peter Hall and Jan Thomas*****

Background

The National Strategic Review of Mathematical Sciences Research in Australia titled 'Mathematics and Statistics: Critical Skills for Australia's Future' covered the spectrum of mathematical activity from school mathematics to advanced level postgraduate courses and research. It had two priorities:

(1) An improved funding model for mathematics and statistics, and
(2) Funding for national infrastructure, initially specifically through improved funding for the Australian Mathematical Sciences Institute (AMSI).

The Review's five key recommendations were linked to actions and key performance indicators (KPIs).

The 2007 May budget provided new funding for mathematics and statistics. Prior to this, AMSI was invited to apply for an out-of-round Collaboration and Structural Reform (CASR) grant. The CASR grant fell well short of the funding recommended in the Review. Further, it became apparent that very little of the new money for mathematics and statistics was being used to support and strengthen mathematical sciences departments in the universities.

At the beginning of 2008 a questionnaire was sent to Heads of Mathematical Sciences in the universities. The questionnaire sought to identify the extent of the flow of new money to mathematics and statistics and responses to the KPIs that were linked to this funding.

Responses

The questionnaire was sent to 40 Heads of Mathematical Sciences 'units'. In two universities statistics is taught in a different faculty. Responses were received from 34 Heads. Of the remaining six institutions, it is likely that only one presently offers a three-year sequence in mathematics and/or statistics and this one is unlikely to continue to do so. This will affect a three-year statistics program being offered by another university that did respond. The viability of their three-year sequence depends on course-sharing with the non-responding institution currently offering a three-year sequence.

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Some general observations:

- There seems to have been a general assumption that in excess of 50% of the new money would go to administration.
- Many departments are trying to do more with fewer resources. One, with less than 10 staff, is teaching up to and including honours with no collaborative teaching through AMSI or the Access Grid network.
- At least two smaller units/groups seem to be in real danger with a 9 to 3 and 6 to 4 drop in permanent staff.
- Few seem to expect their university managers to care about mathematics or statistics.
- There were several comments about the difficulty of getting statisticians and maintaining courses in statistics.
- A number reported likely restructures. A lack of transparency and information about current and future budgets was also apparent in a surprising number of responses.
- Several noted the difficulty of attracting students to mathematics and statistics.
- Universities not offering a three-year sequence in mathematic and/or statistics tend to have large enrolments in teacher education.

Summary responses to the specific questions are below. Insufficient information was provided for quantitative measures other than for staff numbers. However the lack of progress in implementing the Review recommendations is clear.

Question 1. *Please indicate whether you expect some of the additional funding to be passed on during 2008.* Eight indicated yes; for some it was unclear.

If yes, please indicate the percentage of new funding you are likely to receive. Only 3–4 indicated significant increases and they all seemed to accept that is was a percentage after the 'administration' deduction.

If no, are there any indications of increased funding after 2008? There was no optimism that if they had not already got an increase that this situation would change after 2008.

Any further comments? Several commented about changing funding allocations and a general sense from these that budgets filtered down eventually but the model could always change.

Question 2. *Number of permanent academic staff — 'normal' teaching and research only — not full-time research.* On 1 January 2007 there were 596.45 staff. Twelve months later it was 552.95

This has not been broken down into levels but quite a number of the new appointments that were made were at the top end. It is suspected that this was in response to a possible Research Quality Framework (RQF). Thus this decline in staff may reflect an even bigger drop in staff who are prepared to work at the coal face of, for example, service teaching to engineers. A number seemed to be anticipating further appointments during the year but also further retirements.

Some of the non-continuing appointments appeared to be stop-gap measures to cover teaching commitments.

Question 3. *In 2008 are you offering more or fewer courses in mathematics and statistics? Please quantify.* Given Q2, it is remarkable that many said the same. About 11 said fewer and about six said more. In general it was a one or two course change. One 'more' response was from a department that had about eight fewer staff at the beginning of the year.

Question 4. *In 2007 could you offer a three-year sequence leading to a major in mathematics? In 2008?* Two responses were from statistics groups so the sample was 32. Of these six could not offer a three-year sequence in 2007, one of these could in 2008. One responded 'just' to both years and another 'only just' for 2008. Non-respondents would add to these figures.

Question 5. *In 2007 could you offer a three-year sequence leading to a major in statistics? In 2008?* Two responses were from mathematics only teaching departments so the sample was 32. Ten could not offer a three-year sequence in 2007, two said 'with great difficulty' and a couple only if supplemented with mathematics courses. One 'yes' was a 'hope so' for 2008. The difficulty in finding staff was noted by several. Two universities may be affected by the possible break down of shared course arrangements caused by potential staff losses at both of them. Added to the non-respondents, the situation is approaching where only about half the universities can offer a three-year sequence in statistics.

Any further comments concerning course offerings? A couple mentioned help from collaborative arrangements such as the AMSI Summer School and the Access Grid network — initiated through AMSI and its International Centre of Excellence for Education in Mathematics (ICE-EM) — and strengthened by a University of Sydney CASR grant.

Question 6. *Some other key performance indicators from the Review are listed below. Please comment, where relevant, in regard to your institution, especially in the period 2007–2008.*

(a) Staff–student ratios improved: Same, worse or slight improvement.

(b) More tutorials and computer laboratory use: five said 'yes', one said 'worse' and the rest were the same.

(c) Number of new continuing appointments: New appointments seemed to be either necessary replacements to maintain programs or at level E. See reference to possible RQF above.

(d) Number of new non-continuing appointments: Generally seemed to be stop-gap to keep courses running.

(e) More applications from talented mathematicians and statisticians abroad: If they had advertised, generally 'yes', especially for 'pure', but not for statistics.

(f) Student load in mathematics and statistics (quantify if possible): small increases or decreases but nothing noteworthy.

(g) Increased number of service courses taught in mathematical sciences departments (quantify if possible): a few small increases, most the same. One had biology decrease by 30%.

Question 7. *Please attempt to forecast the funding environment for mathematical sciences at your institution in 2009 relative to that for 2008. Will it likely be better, or will it be worse?* Only one or two expected improvement, many were quite pessimistic. 'Same' was common comment.

Anything you would like to add? (Included here are a number of comments that were scattered throughout or in covering notes.)

- Our institution has made it clear that none of the money is to be used for mathematics.
- At faculty level our full income is reflected. Schools within our faculty are then allocated faculty funds in proportion to their income. The problem lies in our faculty not being allocated a proportionate share of the full university's income in a similar manner. Our faculty is thus indirectly subsidising other faculties.
- We offer a major in mathematics, with a proper honours program, but only by having staff over-teaching. This has seriously impacted on research output in mathematics, and collaborative research efforts have not been able to be realised.
- Almost no students want to do maths/stats and load only exists in a few compulsory subjects.
- We are extremely concerned about this year's enrolment and the trend.
- Most education-science students do one introductory course in mathematics and one introductory course in statistics. Mathematics is not emphasised as being important for a science degree.
- Attracting talented staff in statistics particularly difficult.
- Situation better than it has been for years. Have strategic funds to support research, staffing budget up, student numbers up and about to get new building. Supportive new dean arrived three years ago.
- I have given up fighting bureaucracy here. I shall lay down and die or go elsewhere. Perhaps I shall just die. However, given an ounce of encouragement (I do not have even that here), I have been known to bounce back very quickly. When I joined XXX in 1988, as a senior teaching fellow and PhD candidate, the last thing on my mind was that mathematics would not even exist here in 2008! Despite its intrinsic value, with excellent supervisor and highly credible referees, I am now ashamed to even claim my PhD from here.
- XXX is struggling the way many regional universities are struggling — what once was quite a broad offering across disciplines which met the needs of the local region is transforming into a market-driven offering optimised around student demand. There is no mechanism in university policy to prevent the decommissioning of low-enrolment areas of academic endeavour like mathematics. Unless the policy settings at a local and national level are changed, the presence of mathematics in universities at places like XXX will continue to decline. The support of AMSI in this difficult context is much appreciated

— that we add something to the AMSI footprint does, I hope, show that we can work to our mutual benefit.

- In July 2008, we shall be down to two statisticians. It is not hyperbole to suggest that the intention is to remove stats from (a regional university) and have amateurs teach low level service units.
- We have not increased the service teaching we do, but we have strengthened the quality of what we do, and so the threats to remove it from us have disappeared. In this sense, we have improved our service teaching relevance and quality and secured a stronger future for ourselves.

Pre-election part of an email from one Head read:

> I am writing in the harsh light of local university budgeting following the initial euphoria over the change at the Federal level to the funding of the mathematical sciences. At XXX University we are nearing the end of the 2008 budget round, and during the last two or three weeks it was becoming apparent that the expected increased weighting for mathematics and statistics had not been incorporated. I went to see Y, the University Director of Policy and Planning, taking my Head of School with me. Y made it quite clear to us that the change at the Federal level was an ill-thought-out policy, done for political reasons, and that there was no obligation on the university to follow suit. (He also related his 'incredible' expertise in this area, as a former employee of DEST responsible for the original Relative Funding Model, and his on-going association with that section.) We asked how the Federal Government would view this non-implementation of its policy, and in particular the view of Julie Bishop. Y's answer to this was that DEST wouldn't be concerned, and that Julie Bishop wouldn't get involved in such fine detail. I also suggested that this could be raised with the Vice-Chancellor but we were told that our VC was getting similar submissions from all over the university and would not be at all sympathetic .... We left not surprised but nevertheless rather depressed.

Final comments

The results of this questionnaire are extremely disappointing. We believe that there is bipartisan support for improving the mathematical sciences in Australia. The previous government improved core funding. It also provided some funding for AMSI which continues to support collaboration across the mathematical sciences. The current government gives every indication that it is aware of the problems that it has inherited. However urgent action is needed to ensure that government funding for the mathematical sciences is used for what it was intended. And better funding is needed for AMSI to support the collaborative approaches that have sustained so much during this difficult period for mathematics and statistics in Australia.

ANZIAM 2008
The 44th Applied Mathematics Conference

Charlie Macaskill*

The 2008 conference was held at the Carrington Hotel in Katoomba in the Blue Mountains, NSW, from Sunday 3 to Thursday 7 February. The Blue Mountains are a World Heritage listed area with many outstanding bushwalks, but access was limited because of the rain throughout most of the week. This meant that the Carrington Hotel was a welcome refuge from the weather, despite the presence of a few carefully placed buckets catching errant rainwater. Even the welcoming barbecue on Sunday evening had to be moved inside.

The conference was opened on Monday morning by Professor Peter Taylor from the University of Melbourne, the outgoing ANZIAM chair. A broad range of applications was represented over the week, including financial mathematics, fluid mechanics, industrial mathematics, mathematical biology, nonlinear dynamics, operations research and stochastic modelling, with many exciting and interesting problems discussed. There were 135 delegates and 107 contributed talks, 33 of which were presented by students. Talks were of 25 minutes duration and so four parallel sessions were required.

Terry Tao just before the start of his talk.

The strong state of current applied mathematics research was evident in the nine invited presentations given over the four days of the conference, all of which were outstanding:

- Dr Sanjeeva Balasuriya (Connecticut College) (J.H. Michell medallist, 2006), Movers and shakers in dynamical systems: enhancing and quantifying fluid flux
- Professor Sir Michael Berry (University of Bristol), Tsunami asymptotics
- Professor Matthew England (University of New South Wales), The ocean's role in climate variability and climate change
- Professor Ben Leimkuhler (University of Edinburgh), Averages from dynamics
- Professor Linda Petzold (University of California, Santa Barbara), Multiscale simulation of biochemical systems

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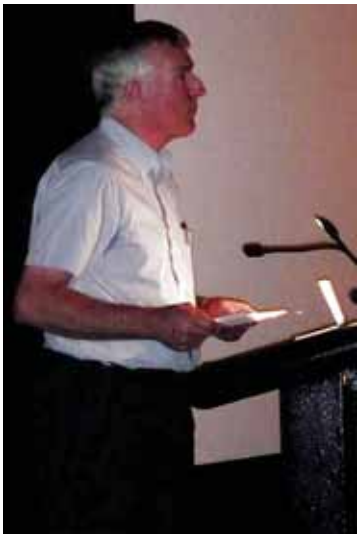
- Professor Andrew Pullan (University of Auckland), Modelling activity of human muscles
- Professor Mick Roberts (Massey University), The evolution and transmission of a virus
- Dr Yvonne Stokes (University of Adelaide) (J.H. Michell medallist, 2007), A mathematical perspective on dripping honey
- Professor Terence Tao (University of California, Los Angeles), Compressed sensing.



Jim Hill,
the ANZIAM 2008 medallist.

Professor Linda Petzold is the 2008 AMSI Lecturer with her expenses at the conference supported by AMSI. Professor Sir Michael Berry was supported by COSNet and the ARC. In addition to his presentation at ANZIAM 2008, he gave a number of talks at the University of New South Wales and the University of Sydney prior to the conference. Additional sponsorship was provided by the University of Sydney. The support of all these organisations is gratefully acknowledged.

The traditional Tuesday afternoon break coincided with a slight improvement in the weather, so that many people were able to see the Three Sisters and in some cases descend down into the Jamison valley. (We believe that everyone returned.) The conference dinner on Wednesday evening was very well attended. There were several notable presentations and announcements.

Professor Jim Hill, from the University of Wollongong, was presented with the ANZIAM medal for 2008 by Professor Ernie Tuck. This is the premier ANZIAM award and the announcement was made to unanimous approval. Dr Carlo Laing, from Massey University, was awarded the 2008 J.H. Michell medal for Outstanding New Researchers. The presentation was made by Professor Larry Forbes. This is the first time that the medal has been given to an applied mathematician from New Zealand. It was also announced that Dr Bill Summerfield would be standing down as Secretary of ANZIAM, a position he has held since 1984. Bill has been the driving force behind the ANZIAM conference for many years. His address, touching on some of the early history of ANZIAM, and its predecessor, the Division of Applied Mathematics of the Australian Mathematical Society, was met by a standing ovation.

Two further awards were made. The award for the best student talk at the conference, the Cherry Prize, was shared by Eleanor Button (University of Melbourne) who spoke on 'Dynamics of water bells formed on the underside of a horizontal plate', and Michael Haythorpe (University of South Australia) whose title was 'Interior-point and other algorithms for solving the Hamiltonian cycle problem based on controlled Markov chains'. Honourable mentions were given to Vivien

Challis (University of Queensland), Sharleen Harper (Massey University, winner in 2007), Lewis Mitchell (University of Wollongong), Anna Ougrinovskaia (University of Sydney) and Abbey Trewenack (University of Melbourne, her 3rd honourable mention!). The announcement was made by Professor Graeme Wake, the chair of the Cherry Prize committee. The other members were Steve Barry, Shaun Hendy, Frank de Hoog, Phil Howlett, Kerry Landman, Mark Nelson, Graeme Pettet, Paul Smith and Song-Ping Zhu. The Cherry Ripe prize, awarded by student vote every year since 1995, was given to Neville de Mestre who spoke on '45 years of Maths lecturing'. He thus becomes the only person to have won this award twice. Runners-up were Graeme Pettet and Peter Taylor. The student committee was organised by Georgina Bignell.

Finally I would like to take the opportunity to thank all those who made the conference possible. The invited speaker committee, chaired by Nalini Joshi, combined extremely well to bring an outstanding group of national and international speakers to the conference. The members of the local organising committee were a pleasure to work with: Dave Galloway (secretary), Mary Myerscough (treasurer) and Martin Wechselberger (timetable) at the University of Sydney and Bruce Henry and Peter Blennerhassett from the University of New South Wales did all the things from day to day and week to week that were needed to make the conference run smoothly and effectively. Students from Sydney University helped with all facets of organisation while the conference was on, particularly Robert Landsberger who kept the computers and overhead projectors running through thick and thin. And finally Bill Summerfield cajoled and checked, helped with detail and organisation, and generally just 'knew what to do'.

Bill Summerfield describes some of the highlights of his 25-year term as ANZIAM Secretary.

Charlie Macaskill is an applied mathematician at the University of Sydney. His PhD was supervised by Professor Ernie Tuck at the University of Adelaide and was followed by postdoctoral work at the (then) Cranfield Institute of Technology and at the University of Cambridge. His current research interests are in geophysical fluid dynamics, particularly vortex dynamics, and in medical applications of acoustics in complex and random environments, typically using numerical or asymptotic methods.

Access Grid Retreat 2008 Report

Bill Blyth*

The AG Retreat 2008 was held on 28–30 May at Simon Fraser University, Vancouver.

This Retreat is an annual event attended by Access Grid (AG) users, developers and researchers. There were presentations suitable for people at all levels of AG technical expertise, from first time AG users to developers in collaborative technology and streaming media. Bill Blyth from AMSI attended and gave a talk on *Australian national collaborative teaching of advanced maths via AG.*

Bill Blyth attending a Jason Bell workshop at the AG Retreat 2008, Simon Fraser University, Vancouver.

The venue was the main lecture theatre and Access Grid Room (AGR) at The IRMACS Centre. This easily accommodated the 50 attendees and provided an impressive environment, with all chairs equipped with power for laptops. IT support was provided to assist all of those who wished to gain wireless connectivity to the internet. All speakers had been asked to prepare pdf slides for their presentation and to make these available one week before the conference. The abstracts and many of the pdf slides for the presentation were on the website before and during the Retreat. Not only did attendees sometimes check their email, but did web searches on the topic under discussion and entered into lively and particularly well-informed discussions at the end of presentations.

A copy of the Retreat program, as a pdf file, and abstracts and slides (a few of which are quite large files, that is, about 50 MB) from the speakers are available at http://www.accessgrid.org/retreat/2008/program .

The only time that the Retreat split into parallel sessions was for the concluding AG Hands-On sessions: one for users and one for developers. All presentations

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covered a wide variety of topics from the perspectives of both users and developers: this provided a great environment for both groups to learn from each other and share ideas.

The keynote address was *Can AG meet the challenges of virtual prototyping?* by Pierre Boulanger, Director of the Advanced Man-Machine Interface Laboratory, University of Alberta. Several examples were given, including the Virtual Analysis of a Francis Turbine at 'La Herradura' in Colombia: a collaboration (using computational fluid dynamics simulation) between agencies in Columbia and universities in Canada and Switzerland. Work on a Virtual Wind Tunnel and modelling low altitude airflow over Mount St Helens involved using the computing power of WestGrid and the AG communication and collaboration tools at each of the research nodes. Pierre commented about remote collaboration using the AG and reported on progress towards developing the next generation of the Tele-Presence System.

Tom Uram, from the Argonne National Laboratory (the originator of the AG), gave an address on the *State of the Access Grid*. The number of AG nodes continues to increase and the AG continues to advance into new domains. Tom was pleased to note the high number of developers attending the Retreat. The new AG release, version 3.1, includes many improvements, increased stability and bug fixes: it is now (almost) of production quality and all AGRs should be using this version.

A lot of work has been done to collect all the AG software and documentation together on the website http://www.accessgrid.org/, which includes a very nice installer for Windows (http://www.accessgrid.org/project/easy_setup). This is really lovely (works a treat!): it installs all the needed software in the required version (AG is very sensitive to having exactly the specified version of the various software components). This assumes you have a Windows machine (whether a laptop or full AGR). With a Mac this process takes a little longer, but you can find lots of guides and tutorials from http://www.accessgrid.org/documentation.

Piers O'Hanlon from University College London presented *The AVATS and SUMOVER projects: The media tools continue*, which improved the media tools VIC (video) and RAT (audio) so that the Access Grid Toolkit could use H.264 video compression and be viewed with the IOCOM software. Many, but not all, problems with RAT have been resolved. Piers asked that all RAT problems and failures be reported to his group. Michael Miller gave an informative and entertaining presentation (complete with audio effects) on *Quality Audio for the Access Grid*.

Jason Bell from Central Queensland University presented *The Global Quality Assurance Program for the Access Grid* and is leading this international project. The QA process should be undertaken by all AGRs in order to minimise technical difficulties. Ian Dennell from the Access Grid Support Centre, University of Manchester, talked about *Testing Access Grid at the Access Grid Support Centre* and the soon-to-be-released AGCheck system which provides automatic testing for the AG.

Many more technical topics included recording of AG sessions, the AG in visualisation and high definition developments using AG. Topics which may be of particular interest to users include the following:

- Some innovative projects outside of science are being undertaken via AGRs: for example choreography for dance and master classes in music. *Connecting dancers — remote choreography* was presented by Tobias Schiebeck from Research Computing at the University of Manchester. This was an interdisciplinary project where the e-Science technologies had to be modified to enable use by choreographers: video needed to be of high quality with more control of video windows (position, sizes and transparency), and importing of common video formats and storage were required.

  Frédérik Lesage, London School of Economics and Political Science and Multimedia Art Research Centres and Electronic Laboratories (MARCEL), presented *Examining the use of experimentation: artists' networks and the Access Grid*. The MARCEL Network is a group of like-minded artists and scientists who want to create a permanent broadband network for artistic experimentation. The presentation examined how the group created spaces for experimentation using the AG and how they developed relationships with academic institutions to test the application of the AG as a platform for artistic performances: an example was of master classes in music (piano). This demanded high quality audio.
- *Using the AccessGrid to conduct interviews about NSF funded research.* The National Science Foundation configured a studio in the University of Illinois' National Center for Supercomputing Applications (NCSA) ACCESS to utilise AG technology for remote on-camera interviews with NSF funded researchers in the field. This is for the purpose of communicating information about activities, programs and research results of the NSF.
- Paul Mercer, from the Arctic Region Supercomputing Center, presented the *ARSC Remote Control Device Project.* Currently the project consists of three remote controlled robots, a $4' \times 8'$ two-level table and a task to be performed. Demonstrations have been made to many groups at local and remote events, including outreach programs to schools in the Fairbanks area, over the past year.
- Todd Zimmerman from WestGrid, Simon Fraser University, presented *The logistics of running an AccessGrid-based seminar series on a national level.* Over the past three years, WestGrid has hosted over 90 AG seminars (involving up to 10–15 sites) and have learned a great deal about managing both the administrative and technological aspects of such events. This talk discussed experiences of hosting the WestGrid Seminar Series and the Coast to Coast Seminar Series and offered some advice for other groups planning on attempting such a series. In terms of future plans, some thoughts were offered on how the seminar series could be expanded to become an AG seminar series on a global level.

  Jonathan Borwein [1, Chapter 2] gives a comprehensive review of the background, history and practice of the Canadian AG coast-to-coast seminar series. You can find the chapter online at http://users.cs.dal.ca/~jborwein/c2c.pdf

in colour, and http://users.cs.dal.ca/~jborwein/c2c08.pdf in black and white with a useful appendix 'Guidelines for Managing a Distributed Seminar'.

- Brian Corrie from WestGrid, Simon Fraser University, presented *The Social Dynamics of Scientific Collaboration*. Firstly, the design, implementation, and usage trends over the past three years of the IRMACS Centre's collaboration infrastructure were discussed. Secondly, a detailed study arising from observations of an active research group was presented. Over five months, 18 hours of meetings were recorded. A careful analysis of the use of gestures was completed and has been published [2].

For all those involved with the Access Grid, whether as a user or developer, participation at an AG Retreat is greatly recommended.

References

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Bill Blyth is Associate Professor (Adjunct) of computational mathematics at RMIT University and was Head of the Department of Mathematics for $6\frac{1}{2}$ years. He is Chair of the Engineering Mathematics Group of Australia, a Centre Affiliate at the International Centre for Classroom Research (at the University of Melbourne), led the design, construction and initial delivery phases of the RMIT University AGR and is currently at The Australian Mathematical Sciences Institute, AMSI, as the national coordinator of AMSI's Access Grid Room project. His PhD was in theoretical physics at Imperial College, London. He has an unusually broad range of research interests in mathematics education (in technology-rich classrooms) and the numerical solution of differential and integral equations. He has published more than 60 refereed papers.

MISG2008
Mathematics and Statistics in Industry Study Group

Tim Marchant* **and Maureen Edwards****

MISG2008, the Mathematics and Statistics in Industry Study Group, was held at the University of Wollongong (UOW), from 28 January to 1 February 2008. The MISG2008 team comprised Professor Tim Marchant (Director), Dr Maureen Edwards (Associate Director) and Ms Joell Hall (Administrator).

From left: Professor Andrew Fowler, Universities of Limerick and Oxford, Dr Jane Sexton, GeoSciences Australia, Professor Tim Marchant, Director MISG2008 and Dr Maureen Edwards, A/Director MISG2008

The event attracted 100 delegates, including 20 postgraduate students, who worked on seven industry projects. Five of these projects were submitted by Australian companies and two were from New Zealand. The disciplines of applied mathematics, financial mathematics and statistics were all represented in the week's activities with many projects having an interdisciplinary flavour.

The invited speaker was Professor Andrew Fowler, from the Universities of Limerick and Oxford. His plenary talk, titled 'Freckles, Volcanos and Rivers: Channelisation in the Industrial and Scientfic World', was well received by the audience. Thanks also to Professor Jim Hill, from UOW and Dr Milorad Kovacevic, Statistics Canada, for their seminars during MISG week.

MISG2008 was opened by Professor Lee Asthiemer, DVC-Research at Wollongong. Many thanks to Lee for attending the opening cermenony, which was held

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on the Australia Day public holiday. The industry project sponsored by Provisor and Food Science Australia, on the 'Shelf life of wine', attracted significant media publicity, with an article appearing in the *Illawarra Mercury*. The photo below accompanied the *Illawarra Mercury* article and shows Tim, Geoff and Philip tackling the shelf life issue in a direct manner; by drinking the contents!

Due to the broad range of skills required to tackle modern industrial mathematics problems, many high-profile scientists from the Australian and NZ statistics and financial mathematics communities attended MISG2008 as delegates or moderators. If the MISG meeting is to remain relevant and important in the coming years then this multi-disciplinary approach to industrial problem solving needs to continue, with participation at MISG from all the mathematical sciences.

From left: A/Professor Geoff Mercer, UNSW@ADFA and Provisor project moderator, Professor Tim Marchant, Director MISG2008 and Mr Philip Giesbertz, Provisor Australia.

Moderation of an MISG project is a challenging task involving problem solving, people management and a very tight deadline. Our thanks and gratitude go to the moderators of each of the MISG2008 projects. See our website for the industry project descriptions from MISG2008, the equation-free summaries of the projects and the project reports, as they become available: http://www.misg.math.uow.edu.au.

Our website also provides details of MISG2009, to be held from 27 to 31 January 2009 at UOW. Professor Alistair Fitt, who is PVC-R at the University of Southampton has agreed to be the invited speaker for MISG2009. He is a regular at the European Study Group in Industry and an acknowledged expert on industrial mathematics. Another exciting development is that UOW is hosting the AMSI Summer School in January 2009 and a course on industrial mathematics will be on offer. It will be possible for postgraduate students to participate in MISG2009 as part of this AMSI Summer School course. We hope to see everybody at UOW for the 2009 event.

Tim Marchant completed a PhD in nonlinear waves at the University of Adelaide in the late 1980s. He is currently Professor and Head, School of Mathematics and Applied Statistics at the University of Wollongong. His research interests include nonlinear waves, nonlinear optics, industrial mathematics and combustion theory.

Maureen Edwards spend a year as a student at James Cook University before a break in food services and as a clerk at Telecom. Returning to study a BMath at University of Wollongong in 1988, she has since stayed on to complete honours, a PhD and take up an academic position. She is currently a senior lecturer in the School of Mathematics and Applied Statistics, with research interests in Lie symmetry analysis and the application of Lie groups to nonlinear partial differential equations.

Obituary

Rowland Sammut
1951–2008

It is with great sadness that we report the death of Rowland Sammut on 17 July 2008.

Rowland gained a first class honours degree and University Medal from the University of New South Wales in 1973. He began his research in fibre optics and waveguide theory in the Department of Applied Mathematics in the Institute of Advanced Studies, ANU. With the brilliance and dedication that Rowland possessed, it was no surprise that in 1976 he gained his PhD and the Crawford Prize for the excellence of his thesis.

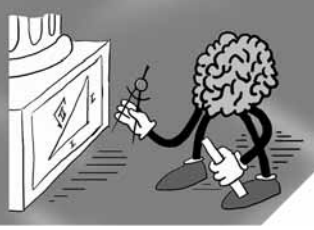
Rowland continued his work on waveguide theory and later became interested in non-linear optics. His extensive and wide-ranging work was internationally recognised and he was made a Fellow of the American Optical Society. Rowland was a regular visitor to the University of Southampton where he contributed to their world-renowned work on fibre design and optical devices. It was during a visit to Southampton that he met his wife, Margaret.

Rowland was a master of the technical formalism of waveguide theory and his papers are models of clarity and inventiveness. In turn he was always in demand as a reviewer whose opinion any editor could absolutely rely on and trust.

Rowland's last years were spent at the University of New South Wales Australian Defence Force Academy (UNSW@ADFA) where he became Professor and Head in the School of Mathematics and Statistics. He gave carefully structured lectures and students benefited from his beautifully presented and meticulous notes.

Rowland was a delightful man and his kindness, generosity and unfailing support will always be remembered by his friends and colleagues.

Colin Pask
UNSW@ADFA, Canberra, ACT 2600. E-mail: c.pask@adfa.edu.au



Maximum number of vertex-disjoint complete subgraphs

Le Anh Vinh*

Abstract

In this paper, we will show that the maximum number of disjoint complete subgraphs K_k in a complete multipartite graph $K_{m_1,m_2,\ldots,m_r}$ with $m_1 \geq m_2 \geq \cdots \geq m_r$ is

$$\min_{1\leq i\leq k} \left\lfloor \frac{m_i + m_{i+1} + \cdots + m_r}{k+1-i} \right\rfloor.$$

Introduction

A graph is multipartite if the set of vertices in the graph can be divided into non-empty subsets, called parts, such that no two vertices in the same part have an edge connecting them. Furthermore, a complete multipartite graph is a multipartite graph such that any two vertices that are not in the same part have an edge connecting them. We denote a complete multipartite graph with r parts by $K_{m_1,m_2,\ldots,m_r}$ where m_i is the number of vertices in the ith part of the graph. For convenience, we arrange parts such that $m_1 \geq m_2 \geq \cdots \geq m_r$. In [1], Sitton discussed the question 'How many edges can there be in a maximum matching in a complete multipartite graph?'. Sitton proved that

Theorem 1 ([1]). *Given any complete multipartite graph $K_{m_1,m_2,\ldots,m_r}$, with $m_1 \geq m_2 \geq \cdots \geq m_r$, the size of a maximum matching is*

$$M = \min\left\{ \sum_{i=2}^{r} m_i, \left\lfloor \tfrac{1}{2} \sum_{i=1}^{r} m_i \right\rfloor \right\},$$

where $\lfloor x \rfloor$ is the integer part of x.

Note that the size of a maximal matching is the maximum number of vertex-disjoint complete subgraphs K_2 in a complete multipartite graph $K_{m_1,m_2,\ldots,m_r}$. A natural generalisation is to find the maximum number of vertex-disjoint complete subgraphs K_k in a complete multipartite graph $K_{m_1,m_2,\ldots,m_r}$ for any value of k. The main result of this note is the following theorem.

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Theorem 2. *Let $k \leq r$ be positive integers and $m_1 \geq \cdots \geq m_r$ be r positive integers. For any complete multipartite graph $K_{m_1,\ldots,m_r}$, let M be the maximum number of vertex-disjoint complete subgraphs K_k. Then*

$$M = \min_{1 \leq i \leq k} \Big\lfloor \frac{m_i + m_{i+1} + \cdots + m_r}{k+1-i} \Big\rfloor.$$

Some lemmas

Before proving Theorem 2, we need the following lemmas.

Lemma 1. *Let M be the maximum number of vertex-disjoint complete subgraphs K_k in a complete multipartite graph $K_{m_1,\ldots,m_r}$. Then*

$$M \leq \min_{1 \leq i \leq k} \Big\lfloor \frac{m_i + m_{i+1} + \cdots + m_r}{k+1-i} \Big\rfloor.$$

Proof. Fix i such that $1 \leq i \leq k$. In any complete subgraph K_k of $K_{m_1,\ldots,m_r}$, there is at most one vertex of this subgraph in each part. Thus, there are at most $i-1$ vertices of this subgraph in $i-1$ parts of sizes $m_1, \ldots, m_{i-1}$. So there are at least $k+1-i$ vertices of this subgraph in $r+1-i$ parts of sizes $m_i, \ldots, m_r$. Since M is the maximum number of vertex-disjoint complete subgraphs K_k in $K_{m_1,\ldots,m_r}$, $M(k+1-i) \leq m_i + \cdots + m_r$. The lemma follows.

Lemma 2. *Suppose that $k \geq 2$. Let M be the maximum number of vertex-disjoint complete subgraphs K_k in a complete multipartite graph $K_{m_1,\ldots,m_r}$ with $m_1 \geq \cdots \geq m_r \geq 1$. If*

$$\frac{m_1 + \cdots + m_r}{k} = \min_{1 \leq i \leq k} \frac{m_i + m_{i+1} + \cdots + m_r}{k+1-i}$$

then

$$M \geq \Big\lfloor \frac{m_1 + \cdots + m_r}{k} \Big\rfloor.$$

Proof. Set $T = \lfloor (m_1 + \cdots + m_r)/k \rfloor$. We will construct T vertex-disjoint complete subgraphs K_k of $K_{m_1,\ldots,m_r}$. The idea is to arrange all but at most $k-1$ vertices of $K_{m_1,\ldots m_r}$ into a $k \times T$ array such that all elements in any column are distinct. We have

$$\frac{m_1 + \cdots + m_r}{k} \leq \frac{m_2 + \cdots + m_r}{k-1},$$

which implies that $(k-1)m_1 \leq m_2 + \cdots + m_r$ or $m_1 \leq T$. Our algorithm is as follows. We fill in entries of a $k \times T$ array eventually by vertices of the 1st, 2nd, $\ldots$, rth parts (the ith part has m_i vertices) from top to bottom and left to right. We have $m_i \leq m_1 \leq T$ so there do not exist two vertices which are both in the same part and the same column. Therefore, each column gives us a complete subgraph of order k. This concludes the proof of the lemma.

Proof of Theorem 2

We will prove this theorem by induction on k. If $k = 1$ then the number of complete subgraph K_1 (a single vertex) in a complete multipartite graph $K_{m_1,\ldots,m_r}$

is $M = m_1 + \cdots + m_r$. Hence the statement holds for $k = 1$. Now suppose the statement holds for all positive integers less than k. We will show that the statement also holds for k. Note that we can assume $k \leq r$, otherwise there is no K_k complete subgraph of $K_{m_1,\ldots,m_r}$. Suppose that

$$T = \frac{m_j + \cdots + m_r}{k+1-j} = \min_{1 \leq i \leq k} \frac{m_i + m_{i+1} + \cdots + m_r}{k+1-i}$$

for some $1 \leq j \leq k$. We have two separate cases.

1. Suppose that $j = 1$. Then from Lemma 2, $M \geq T$. But from Lemma 1, $M \leq T$. Hence $M = T$.
2. Suppose that $j > 1$. Then

$$T = \frac{m_j + \cdots + m_r}{k+1-j} \leq \frac{m_{j-1} + \cdots + m_r}{k+1-(j-1)},$$

which implies that

$$T = \frac{m_j + \cdots + m_r}{k+1-j} \leq m_{j-1}.$$

Hence $T \leq m_i$ for all $i \geq j-1$. From Lemma 2, we can construct T vertex-disjoint complete subgraphs of order $k+1-j$ in $K_{m_j,\ldots,m_r}$. Since $m_i \geq T$ for all $i \geq j-1$, for each complete subgraph of order $k+1-j$, we can add one vertex in the part of size m_i for each $i = 1, \ldots, j-1$ in order to make this subgraph of order k. It is clearly that we obtained T vertex-disjoint complete subgraphs of order k. Thus $M \geq T$. But from Lemma 1, $M \leq T$. Hence $M = T$.

This concludes the proof of the theorem.

References

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Elliptic curves over $\mathbb{Q}(i)$

Peter G. Brown*,** and Thotsaphon Thongjunthug*

Abstract

A study of the diophantine equation $v^2 = 2u^4 - 1$ led the authors to consider elliptic curves specifically over $\mathbb{Q}(i)$ and to examine the parallels and differences with the classical theory over $\mathbb{Q}$. In this paper we present some extensions of the classical theory along with some examples illustrating the results.

The well-known diophantine equation

$$v^2 = 2u^4 - 1\,,$$

has, ignoring signs, only two integer solutions, namely $(u, v) = (1, 1)$ and $(13, 239)$. This is not an easy result to prove (e.g. see [1]).

The change of variable

$$x = \frac{2iv - 2}{u^2}, \qquad y = \frac{-4(v + i)}{u^3}\,,$$

transforms this equation into the elliptic curve

$$y^2 = x^3 + 8x\,.$$

The two integer solutions are transformed as follows:

$$(1, 1) \mapsto (-2 + 2i, -4 - 4i), \qquad (13, 239) \mapsto \left(\frac{2(-1 + 239i)}{13^2}, \frac{-4(239 + i)}{13^3}\right).$$

Thus integer solutions to the diophantine equation become Gaussian rational points on the elliptic curve.

This observation motivated us to look at elliptic curves specifically over $\mathbb{Q}(i)$ to examine the parallels and differences with the classical theory.

Definitions

An *elliptic curve* E (in Weierstrass form) over a field K is an equation of the form

$$y^2 = f(x) = x^3 + Ax + B\,,$$

where $A, B \in K$ and all roots of $f(x)$ are distinct.

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We define $E(L)$ to be the set of ordered pairs

$$\{(x, y) \in L \times L \colon y^2 = f(x)\} \cup \{\infty\},$$

where $L \supseteq K$ is a field. The extra point ∞ is called the *point at infinity*.

It is well known that under a certain operation described geometrically in Figure 1, the set $E(L)$ is an abelian group with ∞ as the identity.

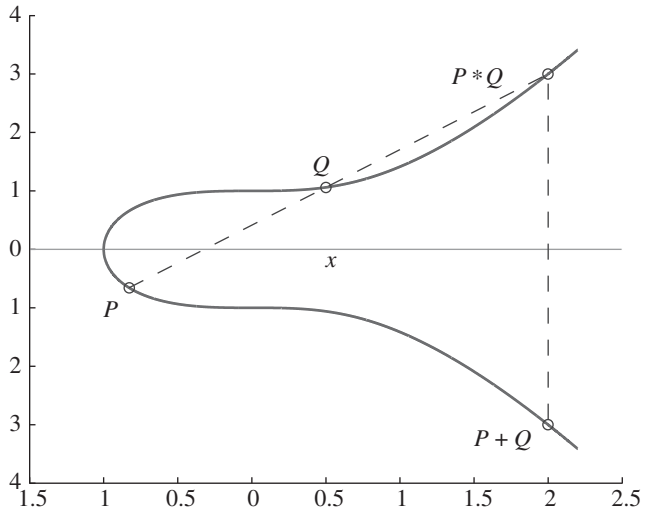

Figure 1.

To *add* points P and Q on the elliptic curve, first we draw a line through the two points. If the line is vertical we define the sum $P + Q$ to be ∞, otherwise, the line will again intersect the curve at a point we will call $P * Q$. Now reflect this point in the x-axis to obtain the point which we will define as $P + Q$. To add P to itself, we take a tangent line at P and use the above. Given two points $P = (x_1, y_1)$ and $Q = (x_2, y_2)$ on an elliptic curve in Weierstrass form, one can easily write down the necessary algebraic formulae for $P + Q$ and for $P + P$. These formulae then become the definition of addition for curves defined over finite and general fields, where the geometric definition has no meaning. Care needs to be taken with fields of characteristic 2 or 3 to avoid division by zero. They will be excluded from our discussion here.

The Lutz–Nagell theorem

A *torsion point* in $E(L)$ is a point of finite order. For elliptic curves over $\mathbb{Q}$, the following theorem (due to Nagell [2], and independently Lutz [3]) gives a simple characterisation of such points.

Theorem 1 (Lutz–Nagell)**.** *Let $E \colon y^2 = x^3 + Ax + B$ be an elliptic curve with $A, B \in \mathbb{Z}$, and let $P = (x, y) \in E(\mathbb{Q})$.*

If P has finite order, then

(1) *both x and y are integers, and*
(2) *either $y = 0$ or $y^2 \mid 4A^3 + 27B^2$.*

Example. Find all torsion points in $E(\mathbb{Q})$ when E is the elliptic curve $y^2 = x^3 + 4$.

Solution. Suppose that $P = (x, y) \in E(\mathbb{Q})$ has finite order. By the Lutz–Nagell theorem, we know that either $y = 0$, or y^2 divides $4A^3 + 27B^2 = 3^3 \cdot 2^4$. Thus the possibilities for y occur in the following list:

$$0, \quad \pm 1, \quad \pm 2, \quad \pm 3, \quad \pm 4, \quad \pm 6, \quad \pm 12\,.$$

Trial and error shows that only $y = \pm 2$ gives x to be an integer. Hence the only possibilities here that need to be checked are $(0, \pm 2)$. Since $(0, -2) = -(0, 2)$, it suffices to check only one point, say, $P = (0, 2)$. By the addition defined above, it can be checked that

$$2P = P + P = (0, -2) = -P\,,$$

hence $3P = \infty$. Thus P and $-P$ have order 3. Therefore the torsion subgroup of $E(\mathbb{Q})$ is

$$\{\infty, (0, 2), (0, -2)\}\,,$$

which is isomorphic to the additive group $\mathbb{Z}/3\mathbb{Z}$.

This theorem can be easily generalised to:

Theorem 2 (Extended Lutz–Nagell theorem)**.** *Let $E\colon y^2 = x^3 + Ax + B$ be an elliptic curve with $A, B \in \mathbb{Z}[i]$, and let $P = (x, y) \in E(\mathbb{Q}(i))$.*

If P has finite order, then

(1) *both x and y are Gaussian integers, and*
(2) *either $y = 0$ or $y^2 \mid 4A^3 + 27B^2$.*

The proof is obtained by a simple modification of the classical proof (e.g. see [4, pp. 89–196] for details of the classical proof).

The torsion group associated to an elliptic curve cannot be arbitrary. Indeed Mazur [5] showed that the range of such torsion subgroups is very limited.

Theorem 3 (Mazur [5])**.** *If E is an elliptic curve over $\mathbb{Q}$, then the torsion subgroup $E(\mathbb{Q})$ is isomorphic to one of the following 15 groups:*

$$\mathbb{Z}/n\mathbb{Z}, \text{ for } 1 \le n \le 12, n \ne 11,$$
$$(\mathbb{Z}/2\mathbb{Z}) \oplus (\mathbb{Z}/2n\mathbb{Z}), \text{ for } 1 \le n \le 4\,.$$

Example. Consider the elliptic curve

$$y^2 + xy - 5y = x^3 - 5x^2\,,$$

which can be transformed into the Weierstrass equation as

$$E\colon y^2 = x^3 - 12987x - 263466\,.$$

Once we consider the torsion subgroup of $E(\mathbb{Q}(i))$, we obtain Table 1.

Table 1.

Order	Points
1	∞
2	$(-21,0)$, $(-102,0)$, $(123,0)$
4	$(-57,\pm 540)$, $(-21-108i,\pm(1296+972i))$, $(33,\pm 810i)$
	$(-237,\pm 3240i)$, $(-21+108i,\pm(1296-972i))$, $(303,\pm 4860)$

Then from this table, it is clear that the torsion subgroup of $E(\mathbb{Q})$ is isomorphic to $(\mathbb{Z}/2\mathbb{Z})\oplus(\mathbb{Z}/4\mathbb{Z})$, which is one of the possibilities given by Mazur's theorem. However, the torsion subgroup of $E(\mathbb{Q}(i))$ now becomes $(\mathbb{Z}/4\mathbb{Z})\oplus(\mathbb{Z}/4\mathbb{Z})$, which is not in Mazur's list.

This is a special case of:

Theorem 4 (Kenku–Momose 1988)**.** *Let F be a quadratic field and E be an elliptic curve over F. Then the torsion subgroup of $E(F)$ is isomorphic to one of the following 26 groups:*

$$\begin{aligned}\mathbb{Z}/n\mathbb{Z},&\ \textit{for } 1\le n\le 18,\ n\ne 17,\\ (\mathbb{Z}/2\mathbb{Z})\oplus(\mathbb{Z}/2n\mathbb{Z}),&\ \textit{for } 1\le n\le 6,\\ (\mathbb{Z}/3\mathbb{Z})\oplus(\mathbb{Z}/3n\mathbb{Z}),&\ \textit{for } n=1,2,\\ (\mathbb{Z}/4\mathbb{Z})\oplus(\mathbb{Z}/4\mathbb{Z}).&\end{aligned}$$

The question as to precisely which torsion subgroups of $E(\mathbb{Q}(i))$ for elliptic curves over $\mathbb{Q}$ can occur is still unresolved. One can also ask the same question for elliptic curves whose coefficients are from $\mathbb{Q}(i)$.

Elliptic curves over $\mathbb{F}_p(i)$, $p\equiv 3 \bmod 4$

The study of elliptic curves over a finite field $\mathbb{F}_p$, p prime, goes back to Gauss.

Theorem 5 (Gauss)**.** *Let E be the elliptic curve*

$$y^2=x^3+kx\,,$$

and $p\ne 2$ be a prime such that $p\nmid k$.

If $p\equiv 3 \bmod 4$, then $|E(\mathbb{F}_p)|=p+1$.

The case $p\equiv 1 \bmod 4$ has also been dealt with, but the answer is not so straightforward.

More generally, one wants to deal with elliptic curves over the finite field $\mathbb{F}_q$, with $q=p^k$, p prime.

The following important result is due to Hasse.

Theorem 6 (Hasse 1933)**.** *Let E be an elliptic curve over the finite field $\mathbb{F}_q$. Then the order of $E(\mathbb{F}_q)$ satisfies the inequality*

$$q+1-2\sqrt{q}\le|E(\mathbb{F}_q)|\le q+1+2\sqrt{q}\,.$$

We take our field now to be $\mathbb{F}_p(i) = \{a + ib\colon a, b \in \mathbb{F}_p\}$ with $p \equiv 3 \bmod 4$. (Note, of course, that $\mathbb{F}_p(i) \cong \mathbb{F}_p$ in the case $p \equiv 1 \bmod 4$.)

This field is isomorphic to $\mathbb{F}_{p^2}$ so Hasse's theorem yields:

$$(p-1)^2 \leq |E(\mathbb{F}_p(i))| \leq (p+1)^2.$$

Returning to the family of elliptic curves in Gauss' result above, we proved:

Theorem 7. *Suppose that E is the elliptic curve of the form*

$$y^2 = x^3 + kx\,,$$

and p is a prime congruent to 3 mod 4 such that $p \nmid k$.

Then $|E(\mathbb{F}_p(i))| = (p+1)^2$, which is the upper bound in Hasse's result.

Proof. The well-known Hasse–Davenport relation (e.g. see [6]) states that if we write $|E(\mathbb{F}_p)| = p + 1 - a$ and $X^2 - aX + p = (X - \alpha)(X - \beta)$ then

$$|E(\mathbb{F}_{p^n})| = p^n + 1 - (\alpha^n + \beta^n)\,.$$

Hence for $p \equiv 3 \bmod 4$, Gauss' result gives $|E(\mathbb{F}_p)| = p + 1$ so $a = 0$ and we write $X^2 + p = (X - i\sqrt{p})(X + i\sqrt{p})$. Hence

$$|E(\mathbb{F}_p(i))| = |E(\mathbb{F}_{p^2})| = p^2 + 1 - ((i\sqrt{p}\,)^2 + (-i\sqrt{p}\,)^2) = (p+1)^2\,.$$

Example. Consider the elliptic curve $y^2 = x^3 + x$ over $\mathbb{F}_3(i)$. A direct calculation gives us Table 2 and thus $|E(\mathbb{F}_3(i))| = 16 = (3+1)^2$.

Table 2.

x	$x^3 + x$	y	Points	Order
0	0	0	$(0, 0)$	2
i	0	0	$(i, 0)$	2
$2i$	0	0	$(2i, 0)$	2
1	2	$\pm i$	$(1, i), (1, 2i)$	4
$1 + i$	2	$\pm i$	$(1 + i, i)$, $(1 + i, 2i)$	4
$1 + 2i$	2	$\pm i$	$(1 + 2i, i)$, $(1 + 2i, 2i)$	4
2	1	± 1	$(2, 1)$, $(2, 2)$	4
$2 + i$	1	± 1	$(2 + i, 1)$, $(2 + i, 2)$	4
$2 + 2i$	1	± 1	$(2 + 2i, 1)$, $(2 + 2i, 2)$	4
∞			∞	1

Mordell–Weil theorem

The group $E(\mathbb{Q})$ of rational points on the elliptic curve E forms an abelian group. In 1922, Mordell [7] showed that this group is finitely generated. This result was generalised by Weil [8]. As a simple consequence of Weil's work, it follows that group $E(\mathbb{Q}(i))$ of Gaussian rational points on the elliptic curve E is also finitely generated.

One of the key tools in Mordell's original proof was his notion of a *height function*, $H(x)$, which attempted to measure how *complicated* a given rational number is.

Mordell defined

$$H(x) = \begin{cases} \max\{|a|, |b|\} & \text{if } x \neq 0,\ x = a/b,\ \gcd(a,b) = 1, \\ 1 & \text{if } x = 0\,. \end{cases}$$

If $P = (x, y) \in E(\mathbb{Q})$ then we can measure its complexity as a rational elliptic point by

$$H(P) = H(x, y) = \begin{cases} 1 & \text{if } P = \infty, \\ H(x) & \text{otherwise.} \end{cases}$$

We can redefine the height function to extend to the Gaussian rationals, as follows:

$$H'(x) = \begin{cases} \max\{|z_1|^2, |z_2|^2\} & \text{if } z \neq 0,\ z = z_1/z_2,\ \gcd(z_1, z_2) = \epsilon, \\ 1 & \text{if } z = 0, \end{cases}$$

where ϵ is a unit in $\mathbb{Z}[i]$ (i.e. one of the numbers $\pm 1, \pm i$).

Then, if $P = (x, y) \in E(\mathbb{Q}(i))$, we define

$$H'(P) = H'(x, y) = \begin{cases} 1 & \text{if } P = \infty, \\ H'(x) & \text{otherwise.} \end{cases}$$

Using this definition, the elementary (but difficult) proof of Mordell can be modified to extend the hypothesis from $\mathbb{Q}$ to $\mathbb{Q}(i)$.

Example. Consider the elliptic curve

$$y^2 = x^3 - 9\,.$$

If we regard this as an elliptic curve over $\mathbb{Q}$, it can be checked that it has a trivial torsion subgroup $\{\infty\}$, and the rank of $E(\mathbb{Q})$ is zero. Thus we have $E(\mathbb{Q}) = \{\infty\}$, that is, there is no rational point (x, y) on this curve.

On the other hand, if we regard this as an elliptic curve over $\mathbb{Q}(i)$, the extended Lutz–Nagell theorem says that the torsion subgroup of $E(\mathbb{Q}(i))$ is

$$T = \{\infty,\ (0, 3i),\ (0, -3i)\} \cong \mathbb{Z}/3\mathbb{Z}\,.$$

It is easy to see that $(2, \pm i) \in E(\mathbb{Q}(i))$. Since $(2, \pm i) \notin T$, they cannot have finite order. Hence we can conclude that

$$E(\mathbb{Q}(i)) \cong (\mathbb{Z}/3\mathbb{Z}) \oplus \mathbb{Z}^r\,,$$

for some integer $r \geq 1$. In other words, there are infinitely many $\mathbb{Q}(i)$-points on this curve. In fact, it can be checked that, for example,

$$\begin{aligned} 2(2, i) &= (-40, -253i)\,, \\ 3(2, i) &= \left(\frac{629}{441}, \frac{22870i}{9261}\right), \\ 4(2, i) &= \left(\frac{-639280}{64009}, \frac{-513439919i}{16194277}\right), \end{aligned}$$

and so on.

Of course, the more interesting question is whether $(0, 3i)$ and $(2, i)$ generate the group $E(\mathbb{Q}(i))$. The techniques used by Mordell can be adapted to answer this question for this curve, but this is beyond the scope of this brief article.

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Book reviews

The mind of the mathematician

Michael Fitzgerald and Ioan James
The John Hopkins University Press, 2007, ISBN 978-0-8018-8587-7

It goes without saying that mathematicians have minds — my two university-educated daughters may disagree with that, but of course we know better. So why write a book about the mind of mathematicians? Well the first point to note is that one of the authors, Ioan James, is a mathematician — naturally. He may be known to some as he is the editor of the Topology journal. The second author, Michael Fitzgerald, is a psychiatrist and psychoanalyst and this fact gives away the emphasis of the book. Prior to this book the only comment I had read about a mathematician from a psychoanalytic point of view was from the famous psychoanalyst Eric Idle, who once wrote 'And Rene Descartes was a drunken fart, I drink therefore I am'. So I was interested to read this book given my singular lack of information about delving into the heart of the mathematician — their mind — and hence their personality.

The book is divided into two parts. The first tries to delve into the mind of the mathematician in just three short chapters. While the second looks at the lives of 20 mathematicians, but not really from a point of their mathematics.

The first chapter is a bit of a hodge-podge of ideas as the authors consider what is the attraction of mathematics. They seem to trot out the standard answers, quoting from people like G.H. Hardy, A. Whitehead and Elie Cartan, mentioning the old joke '[a] mathematician is a scientist who neither knows what he is talking about nor whether whatever he is indeed talking about exists or not' and left me wanting more. Perhaps the section should have been called 'a summary of the literature giving a definition of mathematics'. I would have liked an attempt at an explanation of what it is that drives people to pursue maths. Why do these people spend their time thinking about primes, topology or combinations? Perhaps an examination of whether we have carried over from childhood a natural inquisitiveness. Do we really differ from physicists, or biologists or chemists or . . . ? So much here went wanting. It didn't have to be an in depth exposition; just a summary would have sufficed.

In the section about 'Mathematicians and the Arts', the authors consider music, literature and the visual arts. They cover these fields in just over three pages, with nearly two pages devoted to musical mathematicians. This part is a much better summary and there is a nice counter-example of Mozart being very interested in maths (so he just went up in my estimation). Again they direct to the literature, making this section a good basis for building a more detailed approach for, say, teachers. By and large the most developed section in the first chapter is 'Savant

Skills and Other Phenomena' which is to be expected given one author's field of expertise. They cover the lightning calculators, the child prodigy, and how Asperger Syndrome makes its impact — a theme picked up and developed in a later chapter. At the end of the chapter I felt it was a mixed bag and was asking myself: who was it written for? Certainly it might be of benefit to teachers, but I'm not sure who else.

Chapter 2 looks at mathematical ability and here the book became more purposeful and specific. The first section of the chapter 'Making of a Mathematician' considers cognitive stimulation in early childhood, the position within the birth sequence which translated to the firstborn having a distinct advantage, and the education of a close family member or mentor. The authors looked into whether a mother or father had more influence in their child's mathematical ability. They give specific examples of these cases from well-known mathematicians from the 18th and 19th centuries. It would have been nice to compare with some stats from last century. They do consider briefly the curricula in American childcare centres from recent times and other probably more obscure areas like myopia, allergies, right- or left-handedness and result of ability.

The authors devote over three pages to considering if there is a gender difference in maths ability and consider studies from 1988, 2003, 2005 and a book from 1997 *Women in Mathematics*, so the reader wanting to know more has numerous sources to research. They highlight how women have been ignored in many books in the past, as well as the fact that if they had the ability there was very little opportunity for development — hopefully an issue rectified today, but I do wonder if this is so. Next, maths prodigies are considered, with the observation made that they are often firstborn males. In this section, they give the examples of prodigies Norbert Wiener and William James Sidis (which is an interesting read) and how one was successful and the other not, despite the fact that both had similar abilities. The last aspect examined is of age and achievement. The adage of 'maths is a young person's pursuit' finds support from quotes by Einstein, Hardy and a study by Lehman who found that, for mathematicians, the peak years are from 34 to 40. It seems to me that there needs to be a new Fields Award for those over 40 producing original work, rather than supporting a forgone conclusion.

Chapter 3 examines the dynamics of mathematical creation, an area I found fascinating. Consideration is given to different cognitive styles like visual or verbal thinkers and intuitive or logical thinkers, but all this seems to be an ongoing debate, as there is no survey to conclude one way or the other. Next the authors look at autism. Fortunately some people who have this ability (or disability)

have left a written record of their thinking, like Temple Grandin's *Thinking in Pictures*. They also consider various ways mathematicians work or think, like Galois having difficulty expressing himself verbally because he worked just about exclusively in his head, while Poincaré was an auditory thinker and David Hilbert used gardening as his thinking tool (this delightful reminisce about Hilbert came from Courant). In the section on the unconscious mind, their main data comes from the reflections of Poincaré, Kolmogorov and Gauss with a little appertiser from Einstein. By far the largest section of the chapter is devoted to developmental disorders like schizophrenia and Asperger syndrome — there are some interesting gems here worth reading.

The second part, Chapters 4–8, is devoted entirely to the 20 mathematicians, of whom two were female: Ada Byron (Countess of Lovelace) and Sonya Kovalevskaya. Fortunately, it isn't a rehash of what has appeared in other books that expound the biographies of mathematicians. Here was at least an attempt to look at the human side of them with a very brief look into their characters as best they could. It is as best they could do because much of the character analysis is drawn from biographical books about the mathematicians. The birth dates of these people cover from around the mid-18th century (1736) to very early in the 20th century (1906). So, as can be appreciated, there will be large gaps in our knowledge of the earlier ones covered. Still, the authors make a valiant attempt at analysing the mathematicians and it is interesting to see what they come up with, but of course that is partly because of their sample set. I'll let you read for yourself who has Asperger syndrome and who doesn't, as well as many of the issues covered in the first three chapters. The thing that struck me most when reading their biographies is that many had such tragic lives. I hope that isn't representative of mathematicians! Another aspect that struck me was how young so many were when they died. Some 20% didn't make it to 40 years of age, while 45% didn't make it past 60! Again, I hope that isn't representative.

I'm not sure who is the intended audience of the book; perhaps teachers and students, or just the general reader interested in this topic. If it is the former group, there is a lot here to work with as well as to follow up in the literature. For mathematicians there isn't much new, though Chapters 2 and 3 will provide some interesting reading. If it is for their families then it may be very insightful. I remember Dr Paull from The University of Queensland saying to me once that he thought there was a little bit of Asperger's syndrome in all mathematicians. So being the analytic-analytics that we are I suspect many would have psychoanalysed their own make up by now. While the suggestion of the book is that many mathematicians have these attributes, I suspect that it is a small group, and that the great majority of us are a little more down-to-earth than what is portrayed. Or, as my friend Eric put it, 'I drink therefore I am'. That seems sensible to me.

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Euclid and his twentieth century rivals: diagrams in the logic of Euclidean geometry

Nathaniel Miller
CSLI, 2007, ISBN 978-1-57586-508-9

For over two thousand years, Euclid's *Elements* was regarded as the gold standard in mathematical rigour. By the end of the 19th century various gaps had been noticed — for example where we are asked to consider a point of intersection of two circles, but none of the axioms guarantee that the circles intersect. Hilbert's *Foundations of Geometry*, first published in 1899, provided an account meeting modern standards of rigour. It was however, rather more abstract, and rather less diagrammatic. The book under review sets out to provide a rigorous diagrammatic foundation for plane geometry, and in fact to formalise of the arguments of the first four books of Euclid, by showing that Euclid's proofs can be translated into proofs within a formal system. It also discusses a computer system, called CDEG (computerised diagrammatic Euclidean geometry), which is able to do various calculations within the formal system.

The diagrams that form the basis of the system are somewhat abstract, and contain only topological rather than geometric structure. So, for example, a line segment can be stretched or bent without changing the diagram. A result of this is that we are prevented from making unwarranted assumptions about a diagram as a result of incidental features. For example, if we have a line segment and two points not on the line segment, then we may draw a line segment connecting the two points. But we cannot say, without further information, whether the two line segments will intersect; or if they do whether it is at one of the endpoints or in the interior. As a result case analyses are unavoidable, and the formal system mostly works not with individual diagrams but with *diagram arrays*: sets of diagrams, usually thought of as representing different cases. The formal system then consists of various rules which allow a given diagram array to be replaced by a new one. Some of these increase the number of diagrams (for example, when performing a geometrical construction which involves various cases), while some reduce them (for example, removing a case which turns out to be impossible, or removing an identical copy of an existing diagram).

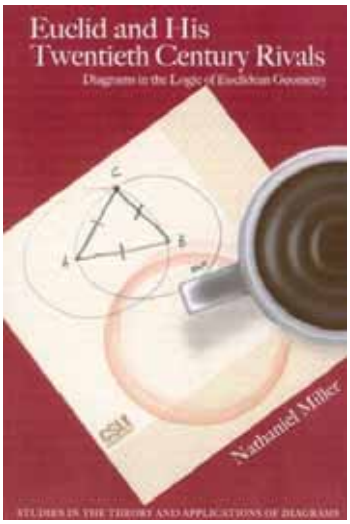
Chapter 1 contains a very readable introduction to the area. Chapter 2 describes the abstract notion of a diagram array (the syntax) and the configurations in the plane they are supposed to represent (the semantics). Chapter 3 describes the various rules for manipulating diagram arrays; it is these rules which are used to construct diagrammatic proofs. Also in Chapter 3 are brief discussions of the extensions needed to deal with arc lengths and with areas, and of the implementation CDEG. Chapter 4 contains some meta-mathematical results about the system.

Overall, the book is written informally. For example most of the time the author deals not with the fully abstract diagrams called *diagram graph structures*, but

with a partially abstract notion called *nicely well-formed primitive Euclidean diagrams*. The latter are actual geometric objects in the plane; but some features are described abstractly, such as which line segments are supposed to be part of the same line. It was not explained how to translate statements about these nicely well-formed primitive Euclidean diagrams into statements about diagram graph structures; indeed even the axioms were only given in the partially abstract language. In fact the author writes

> ... given the complexity of the definitions, a skeptic might not be sure that this system is completely formal until seeing a computer implementation.
>
> [p. 53]

It is therefore disappointing that the implementation CDEG is not, as far as I can see, publicly available. Aside from the question of whether the system is completely formal, it also seems to me that without some computer implementation the system may not be widely taken up. I suspect that on the whole the book will appeal more to those interested in logic and formal systems than those interested in geometry. However it is generally well written, contains a good overview of the topic, and I found the idea of a formal approach to diagrammatic reasoning to be interesting.



Finally, a note on the title: it comes from an 1879 book *Euclid and his modern rivals* by Charles Dodgson (also known as Lewis Carroll).

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AMSI News

Philip Broadbridge*

Recent AMSI involvement in special events

AMSI continues to enhance the activities of the mathematical sciences in research, industry collaboration and education.

Throughout July, AMSI organised a very successful lecture tour by the AMSI Distinguished Lecturer, Professor Linda Petzold of the University of California Santa Barbara. Linda offered three lectures on topics ranging from numerical algorithms for multi-scale systems to circadian clocks in animals. Linda is an enthusiastic ambassador for computational mathematics, generating interest wherever she appears. For her own part, Linda says that she thoroughly enjoyed her visit and will be back in July 2009 as invited speaker at the first Pacific Rim Mathematical Association (PRIMA) Congress, to be hosted by the University of New South Wales on 6–9 July 2009.

The founding institutional members of PRIMA include AMSI, MASCOS (the Centre of Excellence for Mathematics and Statistics of Complex Systems) and the University of New South Wales. This prompted the suggestions to run the first PRIMA Congress in Australia. This congress has grand plans to become the second most important mathematics congress after the International Congress of Mathematics of the IMU. In the week immediately afterwards (13–17 July 2009) in Cairns, Australia will be hosting the joint 18th World IMACS Congress and MODSIM09 International Congress on Modelling and Simulation. In order to succeed both of these international meetings require large numbers of registrants, so please start planning now to attend one or both of them. Closer on the horizon is the 22nd International Congress of Theoretical and Applied Mechanics, to be hosted at the University of Adelaide on 24–29 August 2008. All three of these major events are partly sponsored by AMSI and the promise of such sponsorship was helpful in bids to host them here.

We are grateful to the Department of Education, Employment and Workplace Relations (DEEWR) for funding this year's AMSI industry theme *Mathematics for Environmental and Resource Management*. From early July at the University of Queensland, postgraduate students attended the AMSI Graduate Theme School *Statistics for Resource Management and Environmental Science*. They were privileged to attend courses given by two great lecturers, Professor Peter Guttorp of the University of Washington and Professor Vijay Nair of the University of Michigan. At Surfers Paradise in mid-July, AMSI, MASCOS and the International Centre of Excellence in Water Resource Management (ICE-WaRM) jointly hosted

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an Industry Short Course on the mathematics of water supply and pricing. This covered an interesting variety of topics in civil engineering, environmental monitoring and applied mathematical modelling. Short courses were given by Barbara Lence (University of British Columbia), Shahbaz Khan (UNESCO, Paris) and David Fox (University of Melbourne). Additional invited lectures were given by Quentin Grafton (Australian National University), Graeme Dandy (University of Adelaide) and Mohammed Dore (Brock University).

In June, four Australian students were funded by AMSI to attend the Pacific Institute for the Mathematical Sciences Graduate Industrial Mathematics Modelling Camp held in Saskatchewan. We also partly supported one academic from the University of Western Australia to attend as a facilitator. Several informal accounts indicate that they benefited greatly from the experience.

Following our interesting and vigorous 2007 AMSI-MASCOS theme program, *Concepts of Entropy and their Applications*, Tony Guttmann, Doug Gray and I are guest editors for a special issue of the Zurich-based journal *Entropy*.

Finally, I can report that professional mathematicians have been very much involved in preliminary discussions with the National Curriculum Board. By 2010, the NCB must finalise a national K–12 curriculum in English, Mathematics, Science and History. At the first NCB Forum held late in June, I represented AMSI, Michael Evans represented the International Centre of Excellence for Education in Mathematics, Frank Barrington represented the Australian Mathematical Society and Greg Taylor represented the Australian Mathematics Trust. At that forum, there were widely varying opinions expressed but it became clearer that the government requires specific curriculum content to be set down and that it wants to improve our rankings in international comparisons. Judging by recent meetings and discussions, academic educationists and mathematicians are cooperating better. The national curriculum will be a very important development for mathematics education in Australia and it is vital that we reinforce school mathematics throughout our country.

Director of AMSI since 2005, Phil Broadbridge was previously a professor of applied mathematics for 14 years, including a total of eight years as department chair at University of Wollongong and at University of Delaware.

His PhD was in mathematical physics (University of Adelaide). He has an unusually broad range of research interests, including mathematical physics, applied nonlinear partial differential equations, hydrology, heat and mass transport and population genetics. He has published two books and 100 refereed papers, including one with over 150 ISI citations. He is a member of the editorial boards of four journals and one book series.

News

General News

ANZIAM award for outstanding new researchers: J.H. Michell Medal

Nominations are called for the award of the J.H. Michell Medal for 2009, for ANZIAM outstanding new researchers. Nominees must be in their first 10 years of research on 1 January 2009 after the award of their PhD, and be members of ANZIAM for at least three years. Nominations close on 30 September 2008. For more information, go to http://www.anziam.org.au/Medals/michell.html.

The Chair of the Selection Panel for the 2009 award is Professor Mick Roberts, Institute of Information and Mathematical Sciences, Massey University, Auckland, NZ. Email: m.g.roberts@massey.ac.nz.

Nominations can be made by any member of ANZIAM other than the nominee. A nomination should consist of a brief CV of the nominee, together with the nominee's list of publications and no more than a one-page resume of the significance of the nominee's work. Nominations should be forwarded to the Chair of the Selection Panel, in confidence.

Please note that, where necessary, the Selection Panel will consult with appropriate assessors concerning evaluation of any nominee's research.

New ICMI Executive Committee

A new Executive Committee (EC) of the International Commission on Mathematical Instruction (ICMI) was elected at the ICMI General Assembly held on 6 July in Monterrey, México. ICMI is an official commission of IMU and till now the election was held at the General Assemblies of IMU. It was the first time that the ICMI General Assembly elected the Executive Committee of ICMI; this was decided by the IMU General Assembly held in Santiago de Compostela, 12–13 August 2006. The members of the 2010–2012 ICMI EC, with the various positions held, are as follows.

- President: William Barton (New Zealand)
- Secretary-General: Jaime Carvalho e Silva (Portugal)
- Vice-Presidents: Mina Teicher (Israel) and Angel Ruiz (Costa Rica)
- Members at large: Mariolina Bartolini Bussi (Italy), Sung Je Cho (Korea), Roger Howe (USA), Renuka Vithal (South Africa), and Zhang Yingbo (China).

The term of this next EC will start on 1 January 2010.

Macquarie University: Outreach

A group of some 35 Year 9/10 girls from Carlingford visited the University on 2 July for talks and demomstrations by staff on the applications of mathematics. Initial feedback was enthusiastic about its value in encouraging interest in mathematics.

Staff attended an information evening at Epping Boys High School in early June, and a meeting in April with careers teachers from a large number of state and private schools.

The training sessions for the national team to represent Australia at the International Mathematics Olympiad were hosted on campus in April.

The Department hosted the annual one day meeting in February for feedback to mathematics teachers on the HSC Examinations in Mathematics, organised by the Mathematics Association.

UNSW: 47th Annual Schools Mathematics Competition

The University of New South Wales Schools Mathematics Competition has been run each year since 1962, and this year took place on 25 June. It is open to participation by secondary school students in New South Wales and the Australian Capital Territory. It is run in two divisions: Junior, up to and including Year 10, and Senior, Years 11 and 12.

The competition is designed to assess mathematical insight and ingenuity rather than efficiency in tackling routine examples. Moreover, students are encouraged to enter the competition if they are able to make some progress towards the solution of at least one of the sample problems that are included with the publicity material.

The competition is an open-book exam. Entrants are allowed to take any books and materials, but not computers with internet connections, into the examination.

Each year, about 1000 students participate, 500 in each division, and prizes and/or certificates are awarded to about 60 in each division. In recent years, the UNSW Schools Mathematics Competition has served as one of the selectors for the Australian team in the International Mathematical Olympiad. Some of our winners have gone on to receive medals there.

University of Western Australia

Professor Cheryl Praeger attended the Executive Committee meeting and General Assembly of ICMI (International Commission for Mathematical Instruction) in Monterrey, Mexico, as a representative of the International Mathematical Union Executive Committee.

Completed PhDs

La Trobe University

- Dr P.S.P. Tse, *Geometric numerical integration: on the numerical preservation of multiple geometric properties for ordinary differential equations*, supervisors: Professor G.R.W. Quispel and Dr D. McLaren

Macquarie University

- Dr Craig Antonio Pastro, *Hopf algebras and related structures in a categorical environment*, supervisor: Em/Prof Ross Street

University of Adelaide

- Dr Lynne Giles, *The effects of social networks on the health of older Australians*, supervisors: Gary Glonek and Mary Luszc

University of Queensland

- Dr Liam Wagner, *On the construction of braided pre-monoidal nonassociative categories*, supervisors: Dr Jon Links and Dr Phil Isaac

University of Sydney

- Dr Mauro Grassi, *The isomorphism problem for a class of finitely generated Coxeter groups*, supervisor: Associate Professor Bob Howlett

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Awards and other achievements

University of Sydney

- Professor John Robinson has been awarded the Pitman Medal by the Statistcal Society of Australia 'in recognition of outstanding achievement in, and contribution to, the discipline of Statistics'.
- Dr Daniel Daners has received a University of Sydney Faculty of Science award for excellence in teaching.

University of New South Wales

- Ian Sloan, Scientia Professor in the UNSW School of Mathematics and Statistics, has been honoured with the award of Officer in the General Division of the Order of Australia. The award was announced in the Queen's Birthday honours of 9 June 2008. The award was for 'service to education through the study of mathematics, particularly in the field of computational mathematics, as an academic, researcher and mentor, and to a range of national and international professional associations'.

University of Southern Queensland

- Pat Cretchley has received an Australian Learning and Teaching Council Citation for Outstanding Contribution to Student Learning, 'for advancing undergraduate students' learning and enjoyment of mathematics via sensitive and passionate teaching, research into learning, and scholarly discourse on student learning'.
- Dr Birgit Loch has been awarded a USQ Senior Learning and Teaching Fellowship for semester 1 2009.

Dunedin, New Zealand

Professor of Pure Mathematics

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

Department of Mathematics and Statistics

Applications are invited for the Chair in Pure Mathematics in the Department of Mathematics and Statistics at the University of Otago, to replace Professor Derek Holton who is retiring in April 2009 after 24 years of distinguished service. Candidates should have an outstanding research record, experience in the supervision of masters and doctoral students, and a strong teaching background. Applicants with research interests in any area of pure mathematics are encouraged to apply. Administrative and management experience would also be an advantage. In due course, Professors in the Department usually assume the duties of Head of Department for an agreed period of time.

The Department currently has three professors, four associate professors, 13 lecturers and senior lecturers, two postdoctoral fellows and two teaching fellows. The Department offers majors at the undergraduate level in the three year BA and BSc degrees as well as four year BSc(Hons), BA(Hons) and BAppSc(Hons) degrees. Postgraduate diplomas, MA/MSc and PhD degrees are also offered by the Department. The Department operates a consulting unit, the Centre for Applications of Statistics and Mathematics.

Specific information about the Department and this vacancy may be obtained from the Department's webpage www.maths.otago.ac.nz or from the Pro-Vice-Chancellor (Sciences), Professor Vernon Squire, Tel 64 3 479 7977, Fax 64 3 479 9045, Email vernon.squire@otago.ac.nz.

The Department is committed to diversity in staffing and we encourage applications from women and other groups who are under-represented in the Mathematical and Statistical Sciences. Parental leave without pay of up to 52 weeks and paid parental leave of up to six weeks' salary may be granted to employees with at least one year's service. The University operates childcare centres covering the period from birth to eight years.

Applications quoting reference number A08/100 close on Friday 26 September 2008.

APPLICATION INFORMATION

With each application you must include an application form, an EEO Information Statement, a covering letter, contact details for three referees and one copy of your full curriculum vitae. For an **application form, EEO Information Statement and a full job description go to: www.otago.ac.nz/jobs** Alternatively, contact the **Human Resources Division, Tel 64 3 479 8269, Fax 64 3 479 8279, Email** job.applications@otago.ac.nz

EEO Employers Group

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www.otago.ac.nz/jobs

Appointments, departures and promotions

Flinders University

- Dr Fyodor Sukochev has left the School of Computing Science, Mathematics and Engineering for a position as a Professor of Mathematics at the Unversity of New South Wales. Fyodor has been on the staff at Flinders since June 1994.

- Dr Tim Svenson has resigned from the School of Computer Science, Mathematics and Engineering, to take up a position as an investment analyst with Funds SA from September.

Macquarie University

- Two postdoctoral staff completed their appointments on 30 June 2008. Dr Simona Paoli and Dr Frank Valckborgh take up posts in Israel and UNSW, respectively.

Swinburne University of Technology

- Dr Sergey Suslov has accepted an appointment as a Senior Lecturer in Applied Mathematics. He will join Swinburne in late November.

University of Adelaide

- Professor Tony Roberts will commence his appointment as Professor in the School of Mathematical Sciences in September.
- Dr Steven Lord has been appointed as a post-doctoral Research Associate within the Centre for the Quantification and Management of Risk.
- Dr Glenis Crane has been appointed as a post-doctoral Research Associate within the Centre for the Quantification and Management of Risk.
- Mr Nathaniel Jewell has been appointed as a post-doctoral Research Associate in the School of Mathematical Sciences.
- Dr Michael Teubner has retired.

University of New South Wales

- Chris Tisdell was promoted to Senior Lecturer on 1 July 2008.

University of Southern Queensland

- Pat Cretchley is taking voluntary separation from the University and commencing a Senior Lectureship at Queensland University of Technology shortly.
- Dr David Mander has accepted voluntary separation and left the University in August, after 20 years of service.
- Walter Spunde has accepted voluntary separation and will leave the University after 35 years of service.
- Dr Sergey Suslov has resigned from the University after 11 years of service and will start as Senior Lecturer in Applied Mathematics at Swinburne University of Technology in November.

University of Sydney

- Dr Florica Cirstea has transferred to the University of Sydney from the ANU, and will take up a lectureship at Sydney at the end of April 2009.
- Dr Anthony Henderson has been promoted to Senior Lecturer.

University of Western Australia

- Associate Professor Gordon Royle has joined the School.
- Dr Gopalan Nair has joined the School as Senior Lecturer.

- Dr John Lau has joined the School as Lecturer.
- Dr Sukru Yalcinkaya commences on 11 August as a Research Associate.
- Dr Alice Devillers commences on 29 September as a Research Associate.
- Dr Sven Reichard finished his position as Research Associate in July.
- Dr Tsoy-Wo Ma resigned in July.

University of Wollongong

- Song-Ping Zhu was promoted to Professor in May 2007.

Vale

Flinders University

We are sad to report that Dr Bill Cornish died on 13 July 2008 in Canberra Hospital. Bill was a graduate of the University of Melbourne. He was appointed to Flinders University as a tutor in mathematics in 1966, the first year that the University existed. He became a lecturer in Mathematics in the School of Mathematical Sciences on 1 January 1971, eventually being promoted to Reader on 1 January 1981, a position he held until his retirement from the University on 29 July 1994. He specialised in the area of algebra, particularly lattices and semilattices.

Macquarie University

Sadly, Dr Nick Dungey died at the end of May. Nick was a fine research mathematician with an impressive publication record in analysis, and a promising career in prospect.

Conferences and Courses

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

26th Victorian Algebra Conference

Date: 2–3 October 2008
Venue: RMIT's city campus
Web: http://user.gs.rmit.edu.au/infosec/vac-2008/

Please check the website for links for registration and the submission of abstracts.

More information about the conference dinner and other matters will be distributed soon. In the meantime, you are invited to register and submit an abstract of your proposed talk (or, at least, give an indication of your intention to present a paper).

Algebras, Operators and Noncommutative Geometry

Date: Monday 1 December 2008 to Friday 5 December 2008
Venue: Centre for Mathematics and its Applications, ANU
Web: http://wwwmaths.anu.edu.au/events/aong08/

TRANSITIONS: a one-day workshop on mathematical curriculum issues in the transition from school to university

Date: 3 December 2008
Location: La Trobe University, Bundoora campus
Web: http://wt.maths.latrobe.edu.au/register/Conferences/Transitions/

In honour of Peter Stacey, on the occasion of his retirement. A dinner in Peter's honour will be organised by the Department on the evening of 3 December.

Further information can be obtained from Grant Cairns (G.Cairns@latrobe.edu.au, tel: 03 9479 1106) and Ed Smith (E.Smith@latrobe.edu.au, tel: 03 9479 2548).

7th Australia–New Zealand Mathematics Convention (ANZMC2008)

Date: 8–12 December 2008
Venue: Christchurch, New Zealand
Web: http://www.math.canterbury.ac.nz/ANZMC2008/

4ICC (4th International Conference on Combinatorial Mathematics and Combinatorial Computing)

Date: 15–19 December 2008 Venue: Auckland, New Zealand
Web: http://www.cs.auckland.ac.nz/research/groups/theory/4ICC/

Early-bird registration deadline: 30 September 2008

Special theme program on group theory, combinatorics and computation

Date: 5–16 January 2009
Venue: The University of Western Australia, Perth
Web: http://sponsored.uwa.edu.au/gcc09/
Email: gcc09@maths.uwa.edu.au

The first week will be an international conference in honour of Cheryl Praeger's 60th birthday. This will be followed by an informal week of short courses, workshops and problem sessions, especially benefical to early career researchers and postgraduate students.

CATS 2009. Computing: The Australasian Theory Symposium

Date: 20–23 January 2009
Venue: Victoria University of Wellington, New Zealand
Web: http://velorum.ballarat.edu.au/~pmanyem/CATS09

ANZIAM 2009

Date: 1–5 February 2009
Venue: Rydges Oasis Resort, Caloundra, Queensland
Web: http://www.sci.usq.edu.au/conference/index.php/ANZIAM/2009

The organising committee for the 2009 ANZIAM conference is pleased to advise that the conference will take place at Rydges Oasis Resort, Caloundra, Queensland from Sunday 1 February to Thursday 5 February 2009. Caloundra is about one hour's drive north of Brisbane and the resort can be reached by bus directly from Brisbane and Sunshine Coast airports.

The conference will begin with the traditional Sunday evening BBQ, with the conference dinner to be held on Wednesday evening. Tuesday afternoon will be free for registrants to pursue any of the varied leisure activities available on the Sunshine Coast.

This year again boasts an excellent list of invited speakers covering a broad spectrum of applied mathematics. The speakers are: Prof Jim Hill (Wollongong, ANZIAM Medalist, 2008); Dr Carlo Laing (Massey, JH Michell Medalist, 2008); Prof Ian Turner (QUT); Prof Kerrie Mengersen (QUT); Prof Phillip Maini (Oxford); Dr Graham Weir (Industrial Research Limited, NZ); Prof Guy Latouche (Bruxelles); Prof Natasha Boland (Newcastle).

For further information relating to registration and deadlines, please check the website or contact Peter Johnston (p.johnston@griffith.edu.au) or Scott McCue (scott.mccue@qut.edu.au).

HDA09: 3rd workshop on high-dimensional approximation

Date: 16–20 February 2009
Venue: School of Mathematics and Statistics, University of New South Wales
Web: http://conferences.science.unsw.edu.au/hda09/

Call for papers. The HDA workshop covers current research in all aspects of high dimensional integration and approximation and is open to all with an interest in the area. It is organised under the auspices of the ARC Centre of Excellence in Mathematics and Statistics of Complex Systems, the ANU Centre for Mathematics and its Applications and the DFG SPP 1324: Extraction of Quantifiable Information from Complex Systems.

The scientific committee consists of: Jochen Garcke (Matheon and TU Berlin, Germany); Michael Griebel (U Bonn, Germany); Wolfgang Hackbusch (Max Planck Institute Leipzig, Germany); Markus Hegland (ANU, Australia); George Karniadakis (Brown U and MIT, USA); Frances Kuo (UNSW, Australia); Ian Sloan (UNSW, Australia); Henryk Wozniakowski (Columbia U, USA and Warsaw U, Poland); Harry Yserentant (TU Berlin, Germany).

The program will consist solely of contributed talks (on the principle that everybody is equal) with no parallel tracks and we especially encourage young researchers as well as settled researchers to contribute. Interaction between researchers is one of the main goals of this workshop. We are pleased to already have prominent names agreeing to contribute talks to this workshop (see website).

Please register before 15 October and submit abstracts of talks before 1 November, through the website. The workshop will have no parallel sessions, therefore the number of participants will be limited by the size of the lecture theatre.

Organisers: Dirk Nuyens (UNSW, Australia and KULeuven, Belgium) and Paul Leopardi (ANU, Australia).

Correction

In Issue 35(1) of the *Gazette*, Cheryl Praeger's article entitled 'The essential elements of mathematics: a personal reflection' gave an incorrect reference for the interview of Solomon Marcus (reference [5]). The correct reference is 'Berinde, M. (2003). Interview with Solomon Marcus. *European Math. Soc. Newsletter*, December 2003, 15–17. http://www.emis.de/newsletter/archive_contents.html\#nl_50.' This has been corrected on our website.

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 Takashi Aoki; Kinki University; 1 to 11 September 2008; Painleve equations; USN; N. Joshi

Dr Florent Autin; Université Paris 7; 15 October 2008 to 15 December 2008; maxisets; USN; M. Raimondo

Prof Rosemary Bailey; University of London; 22 to 30 November 2008 and 7 to 20 December 2008; design of experiments; USA; Dr Chris Brien

Prof Thomas Bartsch; Giessen; 1 October 2008 to 15 November 2008; topological methods in nonlinear analysis; USN; E.N. Dancer

Prof Vicek Borkar; Tata Institute of Fundamental Research, India; 11 October 2008 to 1 November 2008; stochastic control and applied probability; USA; Prof Jerzy Filar

Prof Yuri Borovskikh; Transport University; 7 July 2008 to 7 September 2008; asymptotics; USN; N.C. Weber

Prof Dorin Bucur; Universite de Savoie; 1 October 2008 to 30 November 2008; boundary value problems for partial differential equations; USN; E.N. Dancer

Prof Alain Bruguieres; University of Montpellier II; 1 November 2008 to 10 December 2008; Hopf algebras and category theory; MQU; Em/Prof Ross Street

Prof Dorin Bucur; Universite de Savoie; 1 October 2008 to 30 November 2008; boundary value problems for partial differential equations; USN; E.N. Dancer

Dr Nirmalendu Chaudhuri; University of Wollongong; 1 July 2008 to 31 December 2008; applied and nonlinear analysis; ANU; Neil Trudinger

Dr Angelina Yan Mui Chin; University of Malaya; 1 to 30 September 2008; computational algebra; USN; J.J. Cannon

Dr Florica Cirstea; University of Sydney; 14 July 2008 to 14 July 2011; applied and nonlinear analysis; ANU; Neil Trudinger

Dr Denis-Charles Cisinski; University of Paris XIII; 20 August 2008 to 10 September 2008; higher category theory; MQU; Dr Michael Batanin

Prof David Clark; SUNY, New Platz, NY, USA; 15 October 2008 to 15 December 2008; universal algebra; LTU; Drs Brian A. Davey and Jane G. Pitkethly

Dr Robert Clark; University of Wollongong; 1 July 2008 to 1 July 2011; statistical science; ANU; Alan Welsh

Prof Garth Dales; University of Leeds; 2 October 2008 to 24 October 2008; analysis and geometry; ANU; Rick Loy

Dr Tim Dokchitser; Cambridge University; 24 August 2008 to 29 September 2008; computational algebra; USN; J.J. Cannon

Mr Ivan Dynov; Max-Planck Institut fur Mathematik; 1 September 2008 to 31 December 2008; analysis and geometry; ANU; Alan Carey

Prof Ahmad Erfanian; University of Mashland, Iran; May to December 2008; UWA; Prof Cheryl Praeger

Em/Prof Christopher Field; Dalhousie University; 7 November 2008 to 3 December 2008; asymptotic methods in statistics; USN; J. Robinson

Prof Fereidoun Ghahramani; University of Manitoba; 10 November 2008 to 1 January 2009; analysis and geometry; ANU; Rick Loy

Dr Volker Grimm; Duesseldorf, Germany; 12 August 2008 to 9 September 2008; geometric integration; LTU; Prof G.R.W. Quispel

A/Prof Hong Gu; Dalhousie University, Canada; 3 September 2008 to 30 October 2008; –; UMB; Prof Richard Huggins

Prof Zongming Guo; Henan Normal University; 31 August 2008 to 15 November 2008; large solutions of nonlinear elliptic partial differential equations; USN; E.N. Dancer

Dr Paul Hammerton; University of East Anglia; 1 August 2008 to 20 September 2008; –; UAD; Prof Andrew Bassom

Prof Alain B Haurie; University of Geneva, Switzerland; 23 October 2008 to 3 November 2008; control and game theory and their applications in management and environmental modelling; USA; Prof Jerzy Filar

Prof Gerhard Hill; RWTH Aachen University; 21–29 October 2008; –; UWA; Prof Cheryl Praeger and Dr Alice Niemeyer

Prof Chong Chao Huang; Wuhan University, China; June 2008 to January 2009; –; UWA; A/Prof Song Wang

Dr Alexey Isaev; Bogoliubov Laboratory of Theoretical Physics, Russia; 1 October 2008 to 1 December 2008; quantum algebras, their symmetries, invariants and representations; USN; A.I. Molev

Prof Eva Vedel Jensen; University of Aarhus; 26 September 2008 to 3 October 2008; –; UWA; Prof Adrian Baddeley

Prof Takahiro Kawai; Kyoto University; 31 August 2008 to 11 September 2008; Painleve equations and asymptotics of integrable systems; USN; N. Joshi

Prof Satoshi Koike; Hyogo University of Further Education; 5 to 29 September 2008; Trilipschitz properties; USN; L. Paunescu

Dr Philip Kokic; ABARE; 8 July 2008 to 7 July 2009; statistical science; ANU; Alan Welsh

Dr Jacek Krawczyk; Victoria University of Wellington, New Zealand; 1 September 2008 to 7 November 2008; economic and environmental applications of control theory and dynamical systems; USA; Prof Jerzy Filar

Prof Tony Krzesinski; University of Stellenbosch, South Africa; 21 November 2008 to 23 December 2008; –; UMB; Prof Peter Taylor

Prof Harold Kushner; Lefschetz Center for Dynamical Systems, Brown University, USA; 22 September 2008 to 4 October 2008; stochastic control and systems theory; USA; Prof Jerzy Filar

Dr Philippe Lauret; University of La Reunion, Reunion Island; 8 August 2008 to 9 February 2009; mathematical and statistical modeling of energy systems; USA; A/Prof John Boland

Prof Charles Leedham-Green; Queen Mary and Westfield College; 30 December 2008 to 17 January 2009; –; UWA; Dr Alice Niemeyer

Ms Nan Li; The Sichuan Normal University, China; 1 February 2008 to 31 January 2009; –; UWA; A/Prof Song Wang

Dr Martin Markl; Institute of Mathematics of the Academy of Sciences of the Czech Republic; 18 November 2008 to 15 December 2008; higher category theory; MQU; Dr Michael Batanin

Dr James McCoy; University of Wollongong; 1 January 2009 to 30 June 2009; applied and nonlinear analysis; ANU; Ben Andrews

Prof William Messing; University of Minnesota; 20 September 2008 to 29 October 2008; algebra and topology; ANU; Amnon Neeman

Dr Christine Mueller; University of Kassel, Germany; 1 October 2008 to 31 December 2008; –; UMB; Prof Richard Huggins

Dr Gernot Mueller; University of Technology, Munich; 25 October 2008 to 26 December 2008; financial mathematics; ANU; Ross Maller

Dr Alireza Nematollani; University of Shiraz; 15 December 2007 to 15 December 2008; multivariate analysis and time series; USN; N.C. Weber

Prof Sen Huat Ong; University of Malaya; 1 June 2008 to 31 October 2008; financial time series modelling; USN; M.S. Peiris

Prof Shuangjie Peng; Central China Normal University; 15 June 2008 to 31 January 2009; nonlinear elliptic partial differential equations; USN; E.N. Dancer

Prof Helen Perk; Oklahoma State University; 1 August 2008 to 31 May 2009; mathematical physics; ANU; Murray Batchelor

Prof Jacques Perk; Oklahoma State University; 1 August 2008 to 31 May 2009; mathematical physics; ANU; Murray Batchelor

Prof Ulf Persson; Chalmers University; 1 November 2008 to 31 December 2008; algebra and topology; ANU; Amnon Neeman

Dr Frederic Robert; Université de Nice; 14 November 2007 to 3 November 2008; applied and nonlinear analysis; ANU; Florica Cirstea

Dr Jerome Scherer; Universitat Autonoma de Barcelona; 3 September 2008 to 15 December 2008; algebra and topology; ANU; Amnon Neeman

Prof Felix Schulze; Freie Universitat; 20 August 2008 to 2 October 2008; applied and nonlinear analysis; ANU; Ben Andrews

Dr Mahendran Shitan; University Putra, Malaysia; 1 June 2008 to 31 October 2008; theory for the class of generalised autoregression under mathematical statistics/times series analysis; USN; M.S. Peiris

Dr Qiao Shouhong; Sun Yat-sen University, China; 1 March 2008 to March 2009; –; UWA; A/Prof Cai Heng Li

Maryam Solary; Guilan University, Iran; July 2008 to January 2009; –; UWA; A/Prof Song Wang

Dr Damien Stehle; Ecole Normale Superieure, Lyon; 19 July 2008 to 18 July 2009; computational aspects of lattices; USN; J.J. Cannon

Prof Ralph Stohr; University of Manchester; 21 September 2008 to 10 December 2008; algebra and topology; ANU; Laci Kovacs

A/Prof Bijan Taeri; Isfashan University of Technology, Iran; 1 September 2008 to 1 September 2009; UWA; Prof Cheryl Praeger

Prof Yoshitsugu Takei; Kyoto University; 31 August 2008 to 11 September 2008; Painleve equations and asymptotics of integrable systems; USN; N. Joshi

Prof Alexis Virelizier; University of Montpellier II; 1 November 2008 to 10 December 2008; Hopf algebras and category theory; MQU; Em/Prof Ross Street

Dr Mark Weber; University of Paris VII; 1 August 2008 to 20 September 2008; higher category theory; MQU; Dr Michael Batanin

Dr Huoxiong Wu; Xiamen University, China; January 2008 to November 2008; harmonic analysis and partial differential equations; MQU; X.T. Duong

1st PRIMA Congress

July 6-10, 2009

Sydney Australia

University of New South Wales

http://www.primath.org/prima2009/

Plenary Speakers:

Myles Allen (Oxford)
Kenji Fukaya (Kyoto U.)
Seok-Jin Kang (Seoul National U.)
Shige Peng (Shandong U.)
Cheryl Praeger (U. Western Australia)
Gunther Uhlmann (U. Washington)
Federico Ardila (San Francisco & Los Andes)
Nassif Ghoussoub (UBC)
Yujiro Kawamata (U. Tokyo)
Linda Petzold (UC Santa Barbara)
Gang Tian (Princeton)

Scheduled Special Sessions:

ALGEBRAIC GEOMETRY - J. Keum (KIAS), L. Ein (UIC), K. Oguiso (Keio U.)
COMMUTATIVE ALGEBRA - D. Eisenbud (UC Berkeley), A.. K. Singh (U.Utah), K. Watanabe (Nihon)
COMPUTATIONAL ALGEBRA - J. Cannon (U.Sydney), K. Geddes (U.Waterloo)
DYNAMICAL SYSTEMS - D. Lind (U.Washington), T. Dooley (UNSW), G. Froyland (UNSW)
GEOMETRIC ANALYSIS - G. Tian (Princeton), J. Chen (UBC), W.Ding (Peking U.)
INDUSTRIAL APPLICATIONS OF MATHEMATICS - R. Kuske (UBC), A. Tordesillas (U.Melbourne)
INVERSE PROBLEMS - G. Uhlmann (U.Washington), G. Bal (Columbia)
MATHEMATICS OF CLIMATE CHANGE - M. England (UNSW), C. Jones (U.North Carolina)
MATHEMATICAL FINANCE - S. Peng (Shandong U.), I. Ekeland (UBC)
MATHEMATICAL PHYSICS - R. Benguria (U.Catolica de Chile), T. Guttmann (U.Melbourne)
PARTIAL DIFFERENTIAL EQUATIONS - N. Ghoussoub (UBC), Y. Long (Nankai U.)
SCIENTIFIC COMPUTING - L. Petzold (UC Santa Barbara), I. Sloan (UNSW)
STRINGY TOPOLOGY - A. Adem (UBC), Y. Ruan (U.Michigan), C. Westerland (U.Melbourne)
SYMPLECTIC GEOMETRY - K. Fukaya (Kyoto U.), Y. Eliashberg (Stanford)

PRIMA

The Pacific Rim Mathematical Association

AustMS Special Interest Meeting Grants: call for applications

The Australian Mathematical Society sponsors Special Interest Meetings on specialist topics at diverse geographical locations around Australia. This activity is seen as a means of generating a stronger professional profile for the Society within the Australian mathematical community, and of stimulating better communication between mathematicians with similar interests who are scattered throughout the country.

These grants are intended for once-off meetings and not for regular meetings. Such meetings with a large student involvement are encouraged. If it is intended to hold regular meetings on a specific subject area, the organisers should consider forming a Special Interest Group of the Society. If there is widespread interest in a subject area, there is also the mechanism for forming a Division within the Society.

The rules governing the approval of grants are:

(a) each Special Interest Meeting must be clearly advertised as an activity supported by the Australian Mathematical Society;
(b) the organiser must be a member of the Society;
(c) the meeting must be open to all members of the Society;
(d) registration fees should be charged, with at least a 20% reduction for members of the Society. A further reduction should be made for members of the Society who pay the reduced rate subscription (i.e. research students, those not in full time employment and retired members);
(e) a financial statement must be submitted on completion of the Meeting;
(f) any profits up to the value of the grant are to be returned to the Australian Mathematical Society;
(g) on completion, a Meeting Report should be prepared, in a form suitable for publication in the Australian Mathematical Society *Gazette*, and sent to the Secretary;
(h) a list of those attending and a copy of the conference Proceedings (if applicable) must be submitted to the Society;
(i) only in exceptional circumstances will support be provided near the time of the Annual Conference for a Special Interest Meeting being held in another city.

In its consideration of applications, Council will take into account locations around Australia of the various mathematical meetings during the period in question. Preference will be given to Meetings of at least two days duration. The maximum allocation for any one Meeting will be $\$(1,000 + 150n)$ where n is the number of AustMS members registered for and attending the meeting, and with an upper limit of about $5,000. A total of up to $12,000 is available in 2008. There will

be six-monthly calls for applications for Special Interest Meeting Grants, each to cover a period of eighteen months commencing six months after consideration of applications. Please email Secretary@austms.org.au for an application form.

Elizabeth J. Billington
AustMS Secretary
E-mail: ejb@maths.uq.edu.au

Elizabeth arrived at the University of Queensland from England in 1971, for a two-year stay; she is still there now, as a Reader/Associate Professor. Besides being Secretary of the Australian Mathematical Society, she is also Editor-in-Chief of the Australasian Journal of Combinatorics. She has also been on the Council of the Combinatorial Mathematics Society of Australasia for the past eleven years. Her research is in combinatorics; she largely works in graph decompositions and combinatorial designs.

The Australian Mathematical Society

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Business Manager:	Ms May Truong	Department of Mathematics Australian National University ACT 0200, Australia. office@austms.org.au

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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: http://www.austms.org.au.

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Publications

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