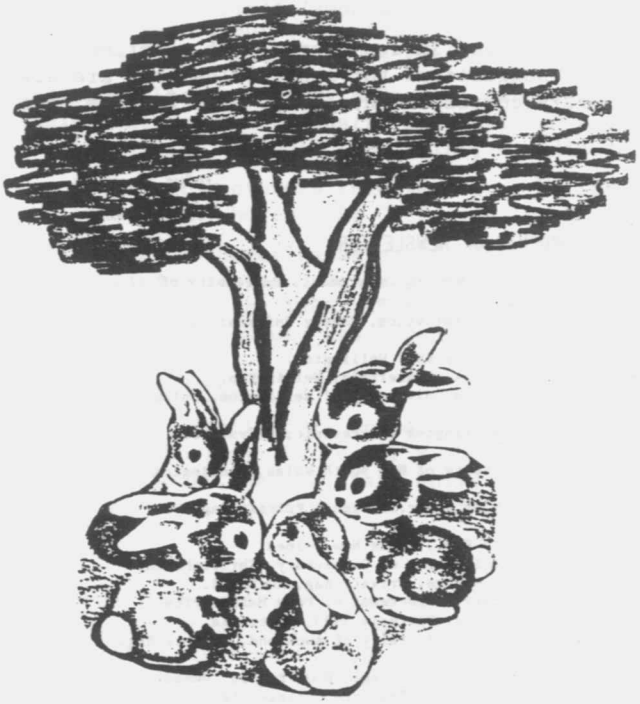
# THE NEW ZEALAND MATHEMATICAL SOCIETY

# NEWSLETTER



FIBONACCI CONVOLUTION TREES

CENTREFOLD

PROFESSOR WILF MALCOLM

CONTENTS



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# Editorial

In this issue Professor John Turner of Waikato University kindly agreed to branch out from knots, the subject of his recently completed D.Phil. thesis, to trees, and provide a feature article on the topic. We hope you enjoy it.

Only once before, when Professor Ian Axford was appointed to Victoria, has a Vice-Chancellor been the subject of a centrefold (Newsletter 21, August 1981). So it is a pleasure to feature in this issue another mathematician, Professor Wilf Malcolm, who was recently appointed Vice-Chancellor at Waikato. We wish him well in his new challenging position.

Readers will be interested (for interested read overjoyed, saddened, indifferent ...) to learn that the editorship of the Newsletter is moving north to Waikato, probably in time for the next issue. I have now produced six newsletters at Otago and I should like to express my gratitude to the many people who have helped during that time. In particular, my thanks to the contributors of feature articles and centrefolds; to honorary correspondents for their local news; to Matt Varnish for his crosswords; to Professor Zulauf for editing the Problems section; to Mike Carter for compiling Conferences; to John Clark for coordinating Book Reviews and to Karen Smeets for her care in typing the bulk of the Newsletter.

The identity of the new editor will be revealed in due course. But meantime, items of news, notices, articles of general interest, suggestions for centrefolds etc. are always welcome and may be sent to one of the honorary correspondents. Copy date for the next issue is 15 July 1985.

*John Curran*
Editor

HONORARY CORRESPONDENTS OF NEWSLETTER

| | |
|---|---|
| Prof. R.H.T. Bates | Electrical and Electronic Engineering Department, University of Canterbury, Private Bag, Christchurch. |
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| Mr M. Doherty | Department of Statistics, Private Bag, Wellington. |
| Dr L. Fradkin | DSIR, Physics & Engineering Labs, Gracefield, Wellington. |
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| Mr I.F. West | Fisheries Research Division, P.O. Box 297, Wellington. |

# Notice

## UNIVERSITY ENTRANCE OPINION SURVEY

Members will recall that the December newsletter included a short questionnaire on university entrance. There were 35 responses, about 18% of membership. Of those who responded, 19 supported option two (a National U.E. examination in 7th form) and 9 option five (open entry to university from age 18, with provision for earlier entry for very able scholars), as being best for mathematics. There was no significant support for any other option. Although members were given the opportunity to discriminate between the needs of mathematics and those of the education system in general, all but two responders gave the same response for both.

In view of the low response rate and the evident divergence of opinion among responders, Council felt it was inappropriate for the NZMS to adopt any official policy on this matter.

To those who took the time to respond, thank you for your cooperation.

*Michael Carter*
President

# Local News

## AUCKLAND UNIVERSITY

### DEPARTMENT OF MATHEMATICS & STATISTICS

#### Arrivals & Departures

Professor John Dettman arrived in the Department in January from Oakland University and will be with us until June of this year.

Dr M.K. Vamanamurthy returned from leave in February. Vaman spent the main part of his sabbatical at Michigan and Michigan State University.

In December, Professor G.A.F. Seber went on study leave for term I and part of term II.

Also in December, Dr Graham Baird resigned to take up a position at the University of Western Ontario. Graham had been with the Department since 1974.

With the retirement of Professor Nield from the Departmental Committee, two new members will take his place. They are Drs Paul Hafner and Ramankutty.

Assistant lecturer Barry McDonald, departed at the end of the year when the tenure of his appointment terminated. Barry has obtained employment with the Department of Preventative and Social Medicine, School of Medicine, Dunedin.

Our assistant lecturers this year are: Mr Ian Hawthorn, Mr R. Chan, Mr M. Paulin, Mr P. Mullins, Dr M. Morton, Dr C. Triggs, Ms C. Brown, Mrs H. Scott and Dr W. Solomon.

With the 25th Summer Research Institute of the Australian Mathematical Society being held at Auckland this year, January was an extremely busy month. The Institute ran from 14 January to 1 February 1985 and many prestigious visitors arrived from overseas to take part. Professor David Gauld was Director for the Institute.

#### Invited speakers were:

Professor D. Brillinger, University of California; Professor P. Saffman, California Institute of Technology; Professor P. Lewis, Naval Postgraduate School, Monterey; Professor E.E. Shult, Kansas State University; Professor G. Gratzer, University of Manitoba; Professor C.W. Gear, University of Illinois; and Professor F. Gehring, University of Michigan.

#### Seminars

Dr R. Stanton (University of Winipeg), *'Breaking a finite log'*.
Professor G.P.H. Styan (McGill University), *'Canonical correlations in the two-way layout'*.
Mr A. McDougall (Advanced Course of Study student), *'The discrete Kalman filter'*.
Mr B. McDonald (Auckland University), *'A beginner's look at survival data analysis'*.

*I.L.R.*

### DEPARTMENT OF COMPUTER SCIENCE

The 25th Summer Research Institute of the Australian Mathematics Society was held in the Department of Mathematics and Statistics, from January 14th to February 1st. When one of the Canadian invited speakers was delayed (by cyclones at Fiji), Garry Tee gave a lecture on *'Sof'ya Vasil'yevna Kovalevskaya'*. Professor Bill Gear, from the University of Illinois, was an invited speaker for the section on Numerical Analysis, which was organized by John Butcher on *'Alternatives to linear multistep methods'*, and by Garry Tee on *'Efficient matrix algorithms'*.

Kevin Burrage and Richard Lobb are both on leave, at the University of Toronto. Rob Burrowes is now the Departmental Technician - Carsten Foehlster has returned to the Federal Republic of Germany, and Ross Gaspard has gone to spend a couple of years in Great Britain. Miss Li Huifang, a telecommunications engineer from Beijing, has come to spend 2 years in our Department, studying Computer Science.

The Science Library extension is largely constructed by now, and the Departmental Computing Laboratory has been installed there. The computers in the Department now comprise (approximately) 42 Zenith Z89, 25 Macintosh, 4 Apple, 3 Epson, 3 Decscope, 3 PDP-11 and 1 LSI-11.

At the start of the second week of the academic year, 609 students had enrolled at Stage 1, 110 at Stage 2, 68 for Stage 3, and there are 15 post-graduate students.

*G.J.T.*

## WAIKATO UNIVERSITY

Roger Hosking returned from a year's leave in Adelaide and Cambridge.

Kevan Broughan is on leave till July, developing NAG-LINK.

Peter Hill is still here. How much longer?

Judi McWhirter has taken Bronwyn Beder's place as Junior Lecturer (on the statistics side), and Deirdre Shea replaced her as laboratory co-ordinator (for the first year C.A.I.)

Seminars

Professor G.P.H. Styan (McGill University), *'Canonical correlation in the two-way layout'.*
Dr M. Fieldhouse (Haverly Systems Europe), *'On time December 3 'Folding the perfect corner' '*, and the polynomial-time algorithm *'50 times faster than MPSX/370'.*
Dr C.G. Gibson (Monash and Liverpool), *'The geometry of robotics'.*

*M.S.*

## MASSEY UNIVERSITY

Tom Hassard will be leaving us towards the middle of the year, to take up a position in Canada. We much regret losing him, but wish him well in his new job and country.

Mike Carter is away on a short period of overseas leave, spending March, April and May in the U.K., South Africa and Australia (chiefly the first-named).

Hugh Morton has been awarded a research fellowship at the Cumberland College of Health Sciences in Sydney. He will be away from mid-May to the end of November, pursuing his research in the mathematical analysis of exercise and sports performance.

Ian Henderson, a zoology graduate from Victoria University, is here on a year's post-doctoral fellowship. He will be working with Mike Hendy, and David Penny of Massey's Botany and Zoology Department, on the phylogenetic analysis of sequence data.

Congratulations to Neville Jeans on the award of his Ph.D. His thesis, supervised by Mike Hendy and Kee Teo, was on the calculation of fundamental units in some types of quartic number fields.

Finally, the Department has recently bought the MuMATH symbolic manipulation system for our IBM PC. We are having an interesting (and sometimes frustrating) time discovering the system's little quirks!

*M.R.C.*

## VICTORIA UNIVERSITY

Ken Russell has resigned to return to his native Australia with a Senior Lectureship at Wollongong, in May. We will miss him sorely, especially at a time when university administrations do not look kindly on departments with the temerity to seek replacements for departed staff.

We welcome our new Teaching Assistant, Linh Nguyen, who will be doing his M.Sc. in time series under Peter Thomson when he returns from sabbatical.

Congratulations to Peter Donelan whose Southampton Ph.D. on kinematics has now been awarded.

There will soon be a review of the mathematical sciences at VUW. A largely external comittee (3 from Australian universities, 2 from other NZ universities, 1 from NZ industry and two from VUW including the Vice-Chancellor) will review the present situation at VUW and recommend directions for future developments in organisation, teaching and research. Submissions will be sought from NZ university heads of relevant departments and from the more mathematically oriented Government departments.

Overseas visitors recently have included Professor Bernard Neumann (ANU) whose seminar was on geometry, and Dr Chris Gibson (Liverpool) on kinematics. Dr Andrew Philpott (Cambridge) on OR, Professor John Dettman (Oakland University, Michigan) on PDEs and Professor Bruce Morton (Monash) on fluid mechanics will also have come by the time you read this.

Later in April Professor George Mackie (Edinburgh), who was VUW's first Professor of Applied Mathematics in the 1960's, will return and give us seminars on fluid mechanics and mathematical methods.

*J.F.H.*

## DSIR

### APPLIED MATHEMATICS DIVISION, MT ALBERT

Tony Aldridge has had success getting the kiwifruit industry to use cusum charts to monitor fruit quality. More than 50 sheds will be using these charts in the coming season. He's received a DSIR study award which will take him to the U.S.A. for a year's study and work experience.

Tony Cooper has been awarded a National Research Advisory Council fellowship for three or more years' Ph.D. study at Stanford University.

Graeme Edwards has resigned, to work as a financial and Operations Research consulant in the private sector.

Peter Thakurdas has transferred from Wellington to Auckland, to work at Industrial Statistics and Operations Research. Recent projects include looking at inventory control for the Post Office, and investigating factors affecting leather quality for the tannery industry.

*J.H.M.*

## CANTERBURY UNIVERSITY

### DEPARTMENT OF MATHEMATICS

Dr Richard Beatson will be arriving in August to take up a lectureship. He is a graduate of Canterbury and is currently an assistant professor at the University of Connecticut. He specialises in numerical analysis and approximation theory.

Professor Bruce Morton, of Monash University (and originally from New Zealand) is visiting us for the whole of the first term as an Erskine Fellow. His main research interest is in environmental fluid mechanics. He will contribute to the Honours 3 course, and will give a series of seminars on vortex motion.

Robert Bull was in Japan for three weeks at the end of last year. He gave seminars at the University of Hiroshima, the Science University of Tokyo, and presented two papers to the annual logic symposium in Hokone.

Peter Renaud returned in January from a year's study leave spent at Macquarrie University.

#### Seminars

Dr R.P. Sullivan (University of Western Australia), a series on *'Idempotent-generated semigroups'*.
Dr Chris Gibson (University of Liverpool), *'Geometry of robotics'*.
Dr G.R. Wood, *'Delphic semigroups'*.

*R.S.L.*

### DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Yeo Tat Soon, a Colombo Plan Scholar who is on the staff of the National University of Singapore and who has been carrying out Ph.D. research under the direction of Professor Bates and Dr D.J.N. Wall (Mathematics Department) for the past 3½ years, has just submitted his thesis entitled *'Diffraction by a penetrable wedge'*. The work reported in this thesis contributes significantly to one of the more persistent and important unsolved problems of classical diffraction theory. Dr Wall and Professor Bates have initiated a joint attack on a range of inverse problems, which have developed from Wall's sojourns at Dundee (in association with D.S. Jones) and the Ohio State University, and Bates' researches over the past quarter of a century into diffraction theory, image processing, radio engineering, astronomical data processing and medical imaging. A fairly recent addition to the group doing research in this area is David Tan, who gained his First in Maths at Canterbury in 1983 and is now working for his Ph.D. in Electrical and Electronic Engineering.

*R.H.T.*

## OTAGO UNIVERSITY

Dr Derek Holton, Senior Lecturer at the University of Melbourne, has been appointed Professor of Mathematics (to fill one of the chairs vacated by Professors Davidson and Sawyer at the end of 1984). He has an established reputation in the field of graph theory and has a special interest in mathematics education. Dr Holton (44) was born in England and educated in Melbourne. He graduated B.Sc. in 1961, Dip.Ed. in 1962, M.A. in 1967; and completed his Ph.D. at McGill University, Montreal, in 1970. Since then he has been a member of the Mathematics Department at the University of Melbourne, a Visiting Fellow at Aberdeen University (Scotland) and a Visiting Professor at Vanderbilt University (USA). He plans to take up his professorship as well as the chairmanship of the Department in early July.

Dr John Clark is now Acting Chairman of the Department.

Three of our 1984 honours graduates are now staff members. Mark Borrie has been appointed Scientific Officer; and both Victor Flynn and James Sneyd are sharing a temporary Assistant Lectureship for the first two terms. After that, they will go overseas to study to pursue their doctorates. (Further details will be available for the next Newsletter.)

Mr Colin Hargreaves, who is a Lecturer in Economic and Social Statistics at the University of Kent at Canterbury (UK), has been appointed "Visiting Lecturer in Statistics" for this year.

Miss Chhondira Chatterjee has recently arrived from Edmonton, Canada (where she has been a consultant and a graduate student in Computer Science) in order to take up an Assistant Lectureship in Statistics. Her research interests are in the fields of Biostatistics and Time Series Analysis.

Dr John Harris has returned from his year's study leave at Indiana University.

Seminars

Dr Derek Holton (University of Melbourne), *'Cycles'*.
Associate Professor Ivan Reilly (University of Auckland), *'Distance and symmetry'*.
Professor Douglas Bridges, (University of Buckingham, UK), *'Constructive Mathematics'*.
Professor Heinz Helfenstein (University of Ottawa, Canada), *'Velocity transformations and hyperbolic space'*.
Dr Chris Gibson (University of Liverpool, UK), *'Geometry of robotics'*.

*G.O.*

## UNIVERSITY OF PAPUA NEW GUINEA

Om Ahuja presented papers to the Indian Mathematical Society Conference in Baroda (in February).

John Boslogo and Janelle Humphreys continue as Senior Tutors for Semester 1. Bernard Duszczyk has been promoted to Associate Professor and presented a paper at the Applied Mathematics Conference in Launceston in February.

Donald Joyce participated in the Summer Research Institute of the Australian Mathematical Society in Auckland in January.

Cecilia Nembou has returned as Lecturer after an interlude in the Bank of PNG.

Ramaswamy Sekkappan has arrived as Senior Lecturer in Statistics; his previous appointment was in the University of Science, Malaysia.

*D.C.J.*

## OPERATIONAL RESEARCH SOCIETY

The 21st annual conference of the Operational Research Society of New Zealand will be held in Wellington on September 2nd and 3rd, 1985. Papers are invited upon all aspects of the theory and practice of Operational Research. Professor G.B. Dantzig is the guest speaker, and thus, papers in the field of Mathematical Programming are particularly welcome. Abstracts of papers (30-40 minutes duration) should be sent to the conference organisers before 11 May 1985.

Conference Organisers
c/o Department of Business Administration
Victoria University
Private Bag
WELLINGTON.

# Secretarial

## MINUTES OF THE SIXTEENTH COUNCIL MEETING

Held in the Science Centre, Wellington on December 6, 1984.

PRESENT: M. Carter (in the Chair), C. Little, J. Shanks, I. Reilly, W. Davidson, P. Hill, J. Harper, M. Jorgensen, E. Kalnins. (Shortly after the meeting began, E. Kalnins departed, feeling unwell, and took no further part in the meeting.)

In attendance: L. Johnston (by invitation).

1. APOLOGIES: None.

   (E. Irving, the President of NZAMT, indicated that he could not come but would send a nominee.)

2. MINUTES OF THE 15TH COUNCIL MEETING ON MAY 6, 1984, AND THE BRIEF COUNCIL MEETING ON MAY 7-8, 1984:

   Moved (JH/WD) that the Minutes be adopted as a true record of the proceedings of these meetings. CARRIED

3. MATTERS ARISING FROM THE MINUTES:

   (a) The response of the RSNZ to the reservations we had expressed about the Prince and Princess of Wales Science Award Scheme was deemed satisfactory. Pleasure was expressed at the fact that an award had been won by P.J. Thomson.

   Moved (WD/PH) that $300 be contributed to the Prince and Princess of Wales Science Award Scheme for 1985. CARRIED

   (b) CL reported receiving a letter from T. Wilson, Editor of the NZ Mathematics Magazine, informing him that the prize-winning projects from the Teachers' Competition were published in Vol 21, No 2. CL agreed to check that due acknowledgement to the NZMS had been made, and, if not, to write to T. Wilson expressing our wish that such acknowledgement be given in future.

   (c) Not much new about the Citizens' Ambassador Program delegation had been received by Council members since the appointment of J.C. Butcher as delegation leader. WD thought that there might have been some linkage with a corresponding delegation being organised in Australia.

   (d) Some confidential information was supplied by MC regarding the Society's nomination to the RSNZ for an Honours Award.

   (e) The Society's policy on University Entrance was discussed, and it was noted that the political situation had changed since the previous meeting. The hope was expressed that the questionnaire drafted by MC could be circulated as a loose sheet inside the next Newsletter. Some discussion of the wording ensued, and Council agreed to a suggestion by MJ that after "(a)" in the first sentence of the questionnaire the word "mathematics" should be replaced by "mathematical".

   Moved (JH/MJ) that the questionnaire as amended be circulated with the next Newsletter. CARRIED

   It was agreed that the Council members from Otago should take the necessary steps to achieve the circulation of the questionnaire as required by the motion.

   (f) WD spoke in support of the proposed fund to aid research and support visits by overseas mathematicians.

   Moved (WD/JH) that a subcommittee, including the President and Treasurer, be constituted and charged to submit to the next Council Meeting a specific proposal concerning the establishment of a fund to aid research and support visits by overseas mathematicians. CARRIED

   During the discussion on the above motion JS pointed out that the fund could be raised from interest on our accounts. MJ suggested that contributions to the fund from individuals should be sought. It was felt to be desirable to have the fund mentioned in the Newsletter separately from the minutes. MC urged that the aims of the fund be as broad as possible. MJ propounded the benefits of the work-in-progress atmosphere to be found in informal workshops as opposed to conferences.

Moved (JH/IR) that WD and CL be appointed to the subcommittee. CARRIED

(g) Debate on the policy for the Pre-Doctoral Thesis Competition centred on suggestions about future competitions made by I. Coope in his second Progress Report, dated 18.4.84, on the 1984 competition. After some discussion on the wording, it was

Moved (WD/JH) that the competition continue to be judged mainly on the quality of the mathematical writing and normally restricted to no more than three entries from each university to keep the judges' task within reasonable bounds. CARRIED

It was agreed that the competition should continue to be open to both master's and honours theses.

(h) (i) Four applications for the fund for travel to conferences had been received by CL, but the Council deemed the applicant J. Graham-Eagle to be ineligible as he is a Post-Doctoral Fellow.

Moved (JH/MJ) that the remaining three applicants be granted $333 each. CARRIED

(ii) MC explained that the question of funds for applicants other than students arose from a letter written by R. Butler, a teacher who had applied for financial assistance for travel to Adelaide to attend ICME. It was pointed out that the existing fund for travel to conferences was designated for post-graduate students. Discussion focussed on people who had difficulty obtaining financial support because of the nature of their employment. The consensus was not in favour of the provision of financial assistance for such people from the Society.

(i) It was agreed that it would be a useful service for the Newsletter to continue listing titles of theses accepted by New Zealand universities. Research bulletins on the other hand tend to be published later as papers and to propagate themselves, and so it was felt that there is no need for the Newsletter to continue publishing their titles.

(j) JS reported that the RSNZ had provided a limited amount of space for storage of archival material. Consequently he had sent a box of such material for storage. The contents include minutes dating back to 1978 but he cannot locate any minutes earlier than that. There were also a number of journals that had been received by the Society. CL revealed that he had brought an additional box of material. MJ and JH agreed to sort the material and to try to fill any gaps. It was agreed that old Newsletters should be stored in the archives, and JH agreed to ask J. Curran if he could supply a complete set.

At this point, IR remarked that L. Johnston was expected to arrive at noon to talk about the printing costs of the Sixth Form Text. Accordingly the meeting adjourned at 11.40 a.m. so that Council members could purchase lunch. Upon the resumption of the meeting at 11.55 a.m. item 8 was brought forward in the agenda.

8. PUBLICATIONS COMMITTEE REPORT:

IR reported on the new run of "Calculus", for which the copyright rests with the Society. Over 1300 copies had been produced - 350 for Victoria, 200 for Waikato, 700 for Auckland and 60 for La Trobe University in Australia, where it sells for A$12. IR will take some spare copies to Sydney next May for promotional purposes. The price in New Zealand is $18 if it is sold directly to students. The bookshop in Hamilton sells it for $22.50.

LJ then reported on the Sixth Form book. Volume 1 was already in existence, having had 1000 copies printed and orders placed for virtually all of them. Volume 2 should be in the hands of the printer by the end of the following week. The total price was $16.50, of which $7.50 was for the first volume and $9.00 for the second, the latter being a slightly longer tome than had been anticipated. Of the total price, the printer receives $9.00, NZMS and NZAMT receive $1.00 each, and the authors receive $2.40 among them, leaving 50¢ for labour, 50¢ for packing and postage, and $1.60 for the fixed initial costs. Thus the cost has been kept as low as possible, and the book has paid for itself.

LJ also presented some bills: $5359 for the printer, $2000 for the typist, of which $1800 needed to be paid now, $288 for diagrams, $50 for extra administrative costs and $335.64 for postage. He remarked that the printer's estimate for the work done by the typist had been $13,000. He also wished to be recompensed for 35 trips to the typist, each trip covering 80 km.

IR asserted that the Society should pay all these bills. He also held that in future the Society and authors should each protect themselves by signing a proper contract, and expressed his regret at not having anticipated the necessity of having a contractual arrangement for this work. Discussion then revolved on the question of what percentage of the sale price the authors should receive as royalty. Reference was made to the minutes of the 14th Council Meeting, where this percentage was described in a motion that carried as negotiable but normally 10%. LJ claimed that no negotiation had taken place and that he had understood from IR that the percentage would be 15%. After considerable discussion it was

> Moved (MJ/JS) that royalties for the book "Secondary School Mathematics" should be 15% of the direct sale price in order to recompense the authors adequately in view of the low direct sale price from the Society. CARRIED

LJ was thanked for his attendance and left the meeting after it had adjourned for lunch at 12.55 p.m.

Upon the resumption of the meeting at 1.20 p.m., IR spoke about the Seventh Form books. R. Broughton was coordinating the writing of the statistics book, and D. Halford that of "Mathematics with Calculus". R. Broughton had expressed the need for liaison between the two writing teams. The matter of contracts was again raised. JH and IR thought that they could locate a copy of an old contract, and if so then IR will make appropriate changes to it and circulate it.

IR had also been asked to report about the legal situation in regard to the Society's making a profit from its publications. He had consulted the former auditor, D. Emanuel, who had assured him that the Society had nothing to worry about, and that it was a common phenomenon for societies to make money in this way.

Discussion then dwelt on the observation that a great deal of the work involved in producing books has nothing to do with writing. Issues raised included the need for a payment to authors for production management, the need for a clearing-house for publications, and whether a distribution fee should be included in the cost of the book. These and related matters were referred to the Publications Committee which was asked to "sort out the whole can of worms" by the next meeting.

Some discussion on L. Johnston's claims for reimbursement followed.

> Moved (IR/JS) that the authors be reimbursed for travel expenses at Public Service rates, and be paid for their work on the figures at the rate of $6.40 per hour. CARRIED

CL agreed to write to L. Johnston to ascertain the amount of time the authors had spent drawing the figures.

IR announced that, as the incoming President, he no longer wished to be Publications Convenor. A replacement needs to be found.

4. CORRESPONDENCE:

> Moved (CL/IR) that the inwards correspondence be received and that the outwards correspondence be noted. CARRIED

Some discussion ensued on the letter written by IR expressing his concern at the apparent overall reduction in the number of Chairs in Mathematics in New Zealand universities. MC reported that as a result of his inquiries regarding the universities concerned, he felt that it would be inappropriate for the Society to take any action on this matter, and this view prevailed.

5. MATTERS ARISING FROM CORRESPONDENCE:

(a) A letter had been received from the RSNZ which attempted to gauge the level of concern among Member Bodies regarding school curricula. MC revealed that he had in his reply indicated that there was a general feeling within the NZMS that those responsible for planning curricula for mathematics do consult widely. WD challenged this opinion, holding that the views of the regional committees are sometimes not considered, and that one consequence was an inordinate quantity of statistics in the curricula. It was agreed that any approach to the Entrance Board Steering Committee about these matters should be made directly, rather than through the RSNZ. It was felt that the incoming Council should take note of this discussion and try to ensure that the Entrance Board Steering Committee seriously considers the views of the regional committees.

(b) MC reported that he had authorised a grant of $50 to help to defray the expenses of the Applied Mathematics Workshop held in Wellington and expressed the hope that Council would support his action. IR commented that he should be applauded for it. It was affirmed that the President does have the authority to spend small amounts of money for the purpose of furthering mathematics.

6. FORDER TRAVEL GRANT:

IR spoke briefly about the Forder Travel Grant. He emphasized that control of the money lies with the London Mathematical Society, not the NZMS. Originally the idea had been to provide the air fare for a British mathematician to visit Auckland, but the concept had been broadened to encompass the whole of Europe on one hand and New Zealand on the other. It was agreed to suggest that the draft document which had been circulated should be amended so that in paragraph 5 the phrase "or their nominees" is inserted after the first occurrence of "Auckland" and the title "Head of the Applied Mathematics Division" is changed to "Director of the Applied Mathematics Division". The intention of the first amendment was to resolve the ambiguity which would arise if the President of the NZMS were to be the Head of the Department of Mathematics and Statistics at the University of Auckland. It was agreed also to suggest the deletion of the clause "otherwise the award would be made biennially" in paragraph 3. IR agreed to try to clarify whether mathematicians interested in receiving the grant had to be nominated or could apply directly. It was agreed that recipients of the grant should be self-supporting or seek financial support from individual departments to cover their expenses while in New Zealand. It was agreed to write to the London Mathematical Society to express our appreciation, and MC agreed to write to D. Gauld to convey the reaction of the Council to this proposal.

7. FINANCIAL REPORT:

JS reported that the Society had about $2000 in debenture stock, and that the publications account contained about $10,000 - $11,000. IR remarked that production of the calculus book would cost about $13,000.

JS tabled a letter from J. Mesirov of the American Mathematical Society. She had suggested that each Society be permitted to advertise without charge in publications of the other. It was agreed to grant the AMS free advertising space in our Newsletter, and to send her a copy of our membership list.

JS remarked that the Society also had an Australian account with only a little money in it, and inquired as to the desirability of keeping it open. It was agreed that it would be convenient to do so in view of the fact of the forthcoming Australasian Mathematics Convention's being held in Sydney and the potential sales of the calculus book in Australia.

JS announced that a box of video cassettes from the Open University was being circulated through the country, and raised the question of whether the NZMS could help to purchase a copy. Each cassette of 25 minutes duration costs $350, while those of 50 minutes duration cost $550 each. Copies could then be duplicated for a copying fee. No consensus was reached, but it was remarked that copies should be available in a film library, and that universities should be encouraged to contribute towards the cost.

JS then spoke to the interim report which he tabled. He remarked on the large number of members who had not paid their subscriptions, and stated that a purge of the membership would occur in January.

Moved (JS/PH) that the interim report be received. CARRIED

9. MEMBER BODIES' COMMITTEE REPORT:

MJ reported that mail for the Member Bodies' Representatitve was still being received by J. Ansell. MJ said that he would try to correct this situation.

10. TEACHERS' PROJECT COMPETITION REPORT:

CL reported that T. Wilson is to be organiser of the 1985 competition, and he had asked whether any changes needed to be made from the formal of the 1983 competition. It was agreed to make no changes.

11. U.S.P. FUND REPORT:

No applications had been received.

12. VISITING LECTURER COORDINATOR'S REPORT:

MC announced that D. Halford had nothing further to report.

MJ said that he had been using the Gazette to determine who would be visiting Australia in 1985. In this way he had learned that Monash University would be visited by D.V. Lindley from March until May, by K.D. McGill of Buffalo from April until June, and by B.R. Seymour until June. In addition S.J. Wilson would be visiting the University of New South Wales until May. PH reported that G. Styan of McGill would be visiting Auckland until May, and that J. Berger of Purdue would visit Canterbury.

It was affirmed that the NZMS underwrites the airfares of the Visiting Lecturer once he is in the country, and MC asked Council members to keep MJ informed if they heard of any mathematician planning to visit New Zealand during 1985.

13. VISITORS' COORDINATION SCHEME:

MC reported that D. Halford wished to be relieved of his position as Coordinator of Visitors at the time of the next Council meeting. He was still keen that a kitset of information about mathematics in New Zealand should be developed.

14. AUSTRALASIAN MATHEMATICS CONVENTION:

JH, WD and PH indicated that they would be unable to attend the next Council meeting if it were held in Sydney. The possibility of holding the meeting in New Zealand prior to the Convention was therefore discussed, but it was agreed to postpone any decision. It was agreed to try to find a person willing to be the incoming Secretary and to co-opt him to the Council before the next meeting. The Society is committed to holding the next AGM in Sydney.

> Moved (MC/MJ) that the registration fee for New Zealanders attending the Australasian Mathematics Convention be set at $100, with a discount of $15 if the fee is paid before March 15, 1985. CARRIED

It was also agreed that the registration fees should be sent to JS, and that the lecture sponsored by the NZMS will be the invited one delivered by R. Leadbetter.

15. AUSTRALIAN APPLIED MATHEMATICS CONFERENCE IN NEW ZEALAND:

MC revealed that I. Collins had sought support from the NZMS for the staging of the 1987 Australian Applied Mathematics Conference in New Zealand.

> Moved (WD/JH) that the NZMS contribute $500 to sponsor an invited speaker. CARRIED

At this point time appeared to press , and so the remaining items on the agenda were reordered.

18. APPOINTMENT OF AUDITOR:

> Moved from the Chair that K. Tunnicliffe be appointed auditor. CARRIED

21. DATE OF ASSUMPTION OF OFFICE OF INCOMING COUNCIL:

It was agreed to change the relevant bylaw to enable the incoming Council to assume office immediately after the AGM.

22. AUTHORS' EXPENSES:

This item was deemed to have been adequately dealt with already.

23. REPRINTING OF EMPLOYMENT BROCHURE:

It was decided not to reprint the employment brochure as the information contained therein is rather dated. PH commented that hundreds of copies are still available at Waikato. MC undertook to discuss the future of this brochure with D. Halford.

26. GENERAL BUSINESS:

MC revealed that the 1988 Mathematical Olympiad will be held in Australia, and that New Zealand had been invited to participate in the Australian training scheme. He reported receiving enthusiastic letters from G. Gale and E. Irving in support of this venture. IR suggested that the event be advertised in the Newsletter. It was agreed that NZAMT, rather thatn the NZMS, should be responsible for overseeing New Zealand's participation in this event.

25. PRESENTATION FOR A.W.F. THYNNE:

It was decided not to contribute towards this presentation.

19. APPOINTMENT OF NEW NEWSLETTER EDITOR:

It was noted that J. Curran wished to resign in May, and a replacement would have to be found.

24. NOMINATIONS FOR A HAMILTON AWARD:

It was agreed that nothing needed to be done at this meeting.

16. VISIT OF P. WHITTLE IN 1986:

MC suggested that as P. Whittle will be visiting New Zealand in April 1986, he may well be a suitable person to be the 1986 Visiting Lecturer.

20. NATIONAL COMMITTEE ON BASIC SKILLS:

JH reported that S. Forbes had not provided him with any information about the formation of this Committee. He undertook to contact her and invite her to submit a paper for the next meeting.

17. HUMAN RIGHTS REPRESENTATITVE:

WD suggested that, if possible, the Human Rights Representative should in future submit matters he wanted to raise at the AGM to the previous December Council meeting so as to obtain the endorsement of the Council. A second option was to publicise such matters in the April Newsletter. A third and less desirable alternative was to submit such items in writing to the Secretary, in the normal way, at least six weeks before the AGM.

The meeting concluded at 4.20 p.m.

*C.H.C. Little*
Secretary

# Book Reviews

ELLIPTIC PARTIAL DIFFERENTIAL EQUATIONS OF SECOND ORDER, by D. Gilbarg and N.S. Trudinger, Springer Verlag, Berlin (1977, 1983), xiii, 513 pages.

New Zealand mathematicians will know Neil Trudinger from conferences here or in Australia, and will have been interested to see the publication of this substantial book, written with D. Gilbarg. Another Australian, L.M. Simon, has also contributed several sections.

O. John, reviewing the volume for Math. Reviews, 57 #13109, said it was a "pleasure to read", and I have enjoyed it too. One can follow the arguments, partly because of clarity of language, partly because there are not too many steps glossed over, and partly because full generality is sacrificed for simplicity, for example structural conditions are given in powers of $|p|$ only.

As the title proclaims, the authors write about second order P.D.E.'s, especially the Dirichlet problem. Half the book is on linear equations, and half on nonlinear, including a chapter on the equation of prescribed mean curvature,

$$(1 + |Du|)^2\Delta u - D_i uD_j uD_{ij} u = uH(1 + |Du|^2)^{3/2} .$$

For linear equations, standard Schauder theory is covered, as well as generalised solutions. The second edition has a new chapter on strong solutions.

For quasilinear equations $a^{ij}(x,u,Du)D_{ij}u + b(x,u,Du) = 0$ they obtain estimates for the sup norm of $u$, the sup norm for $|Du|$ both on the boundary of $\Omega$ and on $\Omega$, and a Hölder norm for $|Du|$ on $\Omega$. A final chapter has been added to the second edition, on fully nonlinear equations such as the Monge-Ampère equation.

This is a book of interest to anyone having to work with differential equations, either as a reference or as a book to learn from. The authors have taken trouble to make the treatment self contained. It would be suitable required reading for a PhD student. Although the material has been developed from lectures at Stanford, it has developed into an almost systematic coverage that is much longer than could be covered in a year's lectures. I think it compares favourably with the Ladyzhenskaya and Ural'tseva book "Linear and Quasilinear Elliptic Equations", with which it has much in common. I am happy to recommend it to you.

*Bruce Calvert*

GALOIS THEROY, by Harold M. Edwards, Springer-Verlag Graduate Texts in Mathematics, (1984), 152 pages, US price approx. $25.40.

In the preface the author says that in studying Galois' original memoir he noticed that "the modern treatments of Galois theory lacked much of the simplicity and clarity of the original". Thus the aim of this text is to explain the theory "in terms close enough to Galois' own to make his memoir accessible to the reader". Indeed, the reader may check whether the author has succeeded in this by reading his translation of Galois' memoir in Appendix 1.

The text itself is very nicely set out. The main body of material consists of about 100 pages divided into 70 short sections. There are no chapters, but the sections are divided up by eight sets of exercises - which the author assures us are not essential to the book. Then follows some 50 pages of additional material, including three appendices (one giving a short synopsis of the theory and another on groups), references and answers to the exercises.

The style is lucid and very readible. There are constant reviews of what has preceded and looks ahead to what is to follow. I have two minor quibbles. Definitions are often introduced informally in the middle of a paragraph and can be missed - though the index helps here. There are a lot of footnotes giving asides, but also many parenthetical remarks which become a little distracting.

In keeping with the approach the author assumes very little terminology or background. For example, the notion of a field is introduced in a very concrete fashion and the only fields considered are extensions of the rationals. However, the author does assume a considerable sophistication in mathematical reasoning. The main results state that certain computations with polynomials produce certain results. In most cases the computations themselves are impractical and it is the idea behind them which must be conceived by the reader.

The first sections give an excellent account of the antecedents of Galois' work. We are led from the Babylonian solution of the quadratic, through Newton's work on symmetric polonomials to Vandermonde's solution of the cubic. Lagrange's more general method of resolvents, which was the principal inspiration of Galois' work is covered, together with Gauss' construction of the $p$-th roots of unity.

The book then focuses on Galois, introducing the idea of the Galois resolvent $t$ (a certain polynomial in the roots such that any polynomial in the roots can be expressed rationally in terms of $t$) and the construction of the field $K(t)$. This is not a great step beyond Lagrange's work but the next sections give Galois' significant contribution. In these the Galois group, a group of permutations of the roots, is defined and used to analyse the structure of $K(t)$. There is a notational difficulty here, in that Galois used the word "substitution" to mean what we know as a permutation, and used that work to mean something else. To avoid misunderstanding the word "permutation" is eschewed from later discussion!

Like his predecessors Galois talks about "the roots" of an equation and extension fields containing them without justification. So the author digresses here to take up this important point of the existence of splitting fields. In particular, as he shows throughout the text, he favours a constructive approach and presents the factoring of polynomials due to Kronecker.

The text is rounded off by the presentation of the Fundamental Theorem of Galois Theory, Galois' work on the $p$-th roots of unity and the general quintic not being solvable by radicals.

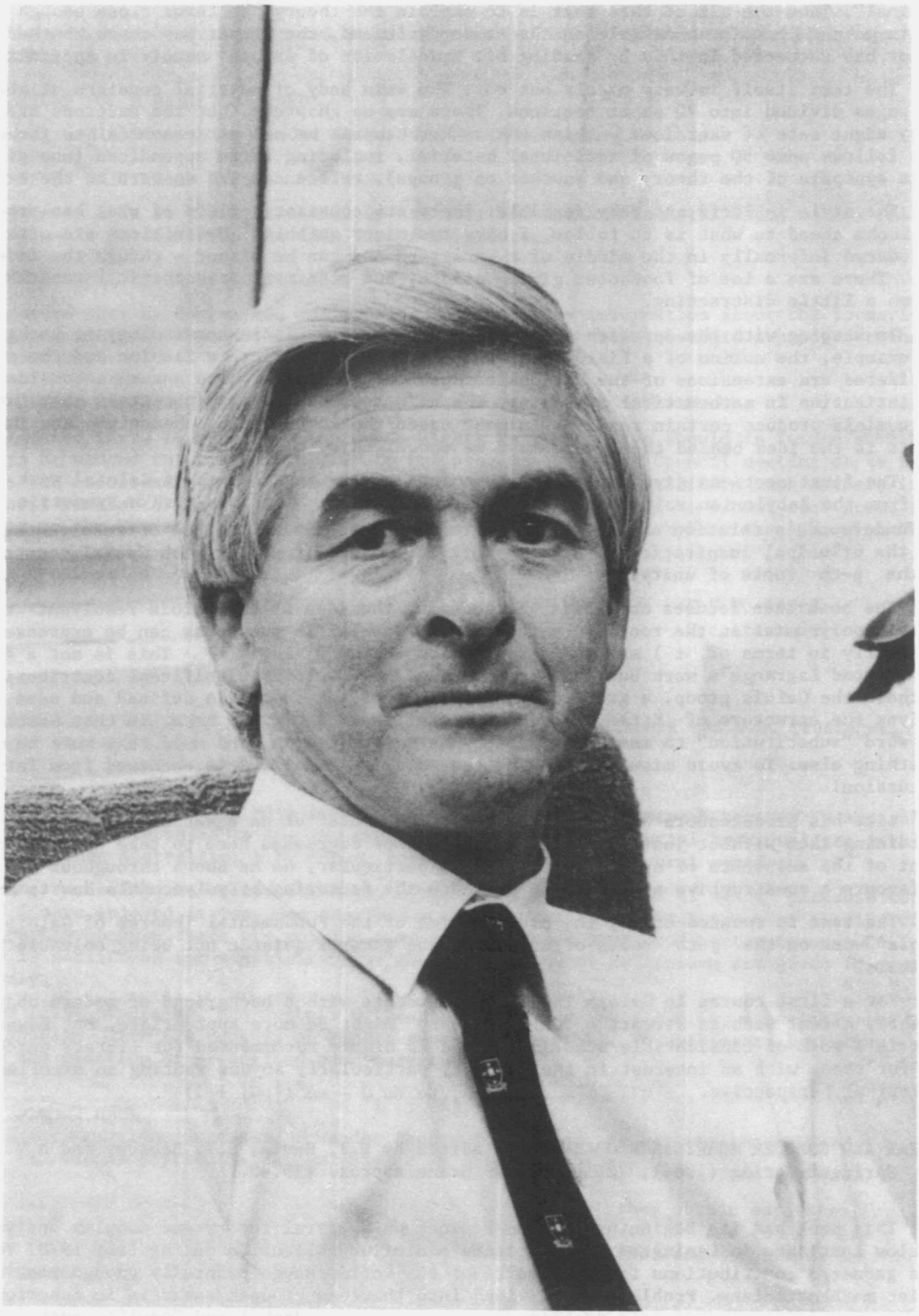
For a first course in Galois Theory for students with a background of modern abstract algebra, a text such as Stewart's "Galois Theory" might be more appropriate. But Edwards' book is a work of considerable scholarship and is highly recommended for library purchase and for those with an interest in the subject, particularly anyone wanting an excellent historical perspective.

*John Curran*

LINEAR AND COMPLEX ANALYSIS PROBLEM BOOK, edited by V.P. Havin, S.V. Hruscev and N.V. Nikolskii, Springer-Verlag (1984), 721 pages, US price approx. $25.40.

This book had its beginnings in the seminar on spectral theory and complex analysis at the Steklov Institute in Leningrad and supplants a similar collection dating from 1978. The editors have garnered contributions from all parts of the world though naturally enough most are from Soviet mathematicians. Problems are divided into thirteen groups: analysis in function spaces; Banach algebras; probabilistic problems; operator theory; Hankel and Toeplitz operators; singular integrals, BMO, $H^p$; spectral analysis and synthesis; approximation and capacities, uniqueness, moments, normality; interpolation, bases, multipliers; entire and subharmonic functions; $\mathbb{C}^n$; miscellaneous problems. The final chapter contains solutions to some of the problems posed in the 1978 book. Each group of problems is prefaced by a brief survey of the field and the problems themselves are set in context with appropriate definitions and results; sometimes there is also a commentary by the editors. A firm editorial hand has brought to the book a consistent, informal style. The layout and printing are most attractive.

*Peter Fenton*



# Centrefold

## PROFESSOR WILF MALCOLM

Wilf Malcolm left the Chair of Pure Mathematics at Victoria University at the end of January to become Vice-Chancellor of Waikato University. We lost a man of integrity, of great intellectual honesty and of quiet determination.

Unlike many mathematicians he was not a child prodigy. He failed U.E. the first time round, but made it to the Wellington Teachers' College in 1951 where he studied concurrently at Victoria, at first in English because they thought trainee teachers always failed mathematics. He proved them wrong the next year, and went on to win a Senior Scholarship and finish his M.A. with First Class Honours in Mathematics.

This background may help to explain his well-known skill in teaching and in communicating both enthusiasm and abstract ideas, but it was his strong Christian faith that guided him into his first position after graduation: Travelling Secretary to the Inter-School Christian Fellowship.

In 1958 he took up a Shirtcliffe Fellowship to Cambridge where he took Parts II and III of the Mathematical Tripos, specialising in algebra and topology, married Ruth, and then returned to Victoria as a lecturer in pure mathematics.

He introduced algebraic topology to Honours level classes in the early 1960s and then moved in the mid-sixties to mathematical logic and the foundations of mathematics. The latter subject eventually percolated much further down than Honours level, helped by his well-known textbook 'Number and Structure'.

From 1964 to 1966 he took another break from mathematics, working as General Secretary of the Inter-Varsity Fellowship of Evangelical Unions (later the Tertiary Students' Christian Fellowship), but returned to lecturing at V.U.W. in 1967.

The following year he became a senior lecturer; in 1972 he completed his Ph.D. thesis on ultraproducts and high order models; in 1975 he was promoted to reader and soon afterwards was appointed to the Chair of Pure Mathematics which he held until recently.

What has marked Wilf's work over the last decade particularly has been his willingness to share in the wider responsibilities of university management. In his chairmanship of the Leave Committee he brought to the V.U.W. research and study leave system a concern for fairness and, in particular, a conviction that staff should be treated equally, regardless of rank. As Academic Pro-Vice-Chancellor he guided many reviews of policies and procedures through the Academic Committee and the Professorial Board, and more recently he was the key figure in the discussions and negotiations over the possibility of closer relations between the University and the Wellington Clinical School.

Relationships with the Wellington Teachers' College, at times marked by mutual suspicion, improved considerably while he was on the College Council, with his careful work to reassure the staff and Councils of both institutions.

These exercises called for considerable patience and tact and an equally considerable amount of hard drafting work.

From Victoria we can take some pride in the appointment of one of our own graduates and long-serving staff members to Waikato's Vice-Chancellorship. We congratulate Wilf on his appointment; we thank him for all his work for the Mathematics Department and Victoria in general; we hope he is not entirely lost to mathematics; and we wish him and his family all the best as they settle in Hamilton.

*Adapted from News VUW by John Harper*

# Feature Article

## FIBONACCI CONVOLUTION TREES AND INTEGER REPRESENTATIONS

J.C. TURNER

UNIVERSITY OF WAIKATO

The Editor invited me to supply an article "of general interest, omitting details" for the Newsletter. I hope that my topic and exposition fills that bill. The objects I am about to describe will display attractive relationships between the positive integers and the Fibonacci numbers 1, 1, 2, 3, 5 ... The former have been a source of wonder and delight to mankind since the dawn of reasoning, and the latter have been studied by mathematicians since Leonardo of Pisa, son of Bonacci, wrote of them in his *Liber Abaci* in 1202 A.D. Surely, then, the "general interest" part of my brief is satisfied. I will comply with the "details" part by omitting most proofs and letting diagrams speak for themselves.

In [1] the author shows how to construct a sequence of binary trees $\{T_n\}$ such that the tree $T_n$ has $f_n$ leaf-nodes, where $f_n$ is the n-th number in the Fibonacci sequence. He then demonstrates several remarkable properties of his Fibonacci trees. In [2] we study certain stochastic processes defined on the trees.

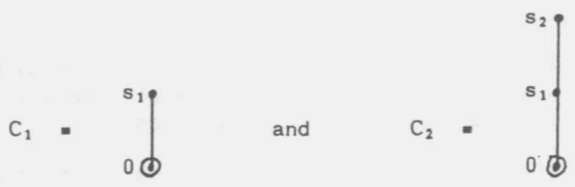
In this paper I give a construction for trees that are slightly different from the Fibonacci trees. I then show how to weight the tree nodes with integers from a general sequence $s = \{s_1, s_2, \ldots\}$, using a sequential method I like to call the 'drip-feed principle'. This produces a sequence of binary trees $\{C_n\}$ which I call 'Fibonacci convolution trees'. The reason for the name is that the sum of the weights assigned to the nodes of $C_n$ is equal to the n-th term of the convolution of $f$ (the Fibonacci sequence) and $s$ (the general sequence). That is, using $\Omega$ to mean "sum of weights", we have

$$\Omega(C_n) = (f*s)_n = f_1 s_n + f_2 s_{n-1} + \ldots + f_n s_1 .$$

After tabulating a list of parameters of the convolution trees, whose formulae are expressible in strikingly simple terms of Fibonacci numbers, I give some applications and show how a study of path weights reveals certain Fibonacci representations of the integers. A fundamental result in this topic is Zeckendorf's theorem [3]; using a modified drip-feed principle and Fibonacci weights, I produce a weighted convolution tree sequence which effectively proves the existence of the Zeckendorf integer representation.

### 1. Fibonacci convolution trees

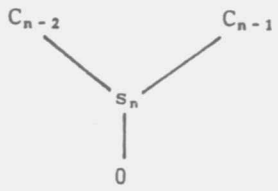
The Fibonacci convolution trees are defined by a *recurrence construction* which builds the trees $\{C_n\}$ sequentially, assigning the integer weights $\{s_n\}$ as they are built. The method parallels the definition of Fibonacci numbers (namely $f_n = f_{n-2} + f_{n-1}$, with $f_1 = 1$, $f_2 = 1$), with a binary operation $\oplus$ which works as follows: We define the initial rooted trees to be




Then given any two consecutive trees $C_{n-2}$, $C_{n-1}$, we obtain the next tree by

$$C_n = C_{n-2} \oplus C_{n-1} ,$$

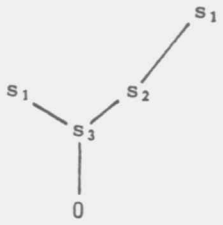
the joining operation $\oplus$ being indicated by the diagram:

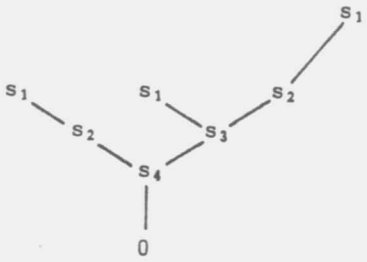



Note: the node receiving the new weight $s_n$ is formed by coalescing the roots of the previous two trees; then a new stem and root is added. Every root is given zero weight.

Diagrams of $C_3$ and $C_4$

The next two trees in the sequence are then

$C_3 = C_1 \oplus C_2 =$ 


and $C_4 = C_2 \oplus C_3 =$ 


The 'drip-feed principle' referred to above is the insertion of the elements of the sequence $s$ one at a time, $s_i$ being assigned to a newly formed node in $C_i$, $i = 3, 4, \ldots$.

Table of properties of tree $C_n$

The following table gives formulae for many topological properties of the weighted tree $C_n$. It is remarkable how many of the parameters have values expressible so simply in terms of the Fibonacci numbers.

Notes: The *valency* of a node is the number of edges joined to it. The *level* of a node in a rooted tree is the length (number of edges) of the path from the root to the node. The *height* of a rooted tree is the maximum level occurring.

| | Parameter | | Value for tree $C_n$ |
|---|---|---|---|
| (i) | Number of nodes | | $f_{n+2}$ |
| (ii) | Number of edges | | $f_{n+2} - 1 = \sum_1^n f_i$ |
| (iii) | Number of nodes of valency | $d = 1$ | $f_n + 1$ |
| | | $d = 2$ | $f_{n-1}$ |
| | | $d = 3$ | $f_n - 1$ |
| (iv) | Number of leaf-nodes | | $f_n$ |
| (v) | Sum of all node weights | | $(f*s)_n$ |
| (vi) | Height | | $n$ |
| (vii) | Lowest level leaf-node | | $\left[\frac{n}{2}\right] + 1$ |
| (viii) | Number of leaf-nodes at level $m$ | | $\binom{m-1}{n-m}$ |

Example 3 (general $s$) We have already noted the *fundamental convolution property*, namely:

$$(f*s)_n = (f*s)_{n-2} + (f*s)_{n-1} + s_n ,$$

where $f$ is the Fibonacci sequence and $s = \{s_1, s_2, \ldots\}$ .

We now examine the effect on the total weight (say $\Omega_n(s)$) of the $n$th convolution tree when $s$ is changed to $s^{(r)} = \{s_{r+1}, s_{r+2}, \ldots\}$ . In terms of the shift operator $E$, operating on the subscripts of the sequence terms $s_i$, we can write $s^{(1)} = Es$ ; and, in general, $s^{(r)} = E^r s = \{s_{r+1}, \ldots\}$ . Let us also introduce the difference operator $\Delta$, now operating on subscripted terms, so that $\Delta s = \{s_2 - s_1 , s_3 - s_2 , \ldots\}$ . Then the following results hold, pertaining to the total weight of the convolution trees.

Theorem

(i) $$\delta^{(1)}_n \equiv \Omega_n(Es) - \Omega_n(s) = (f*\Delta s)_n ;$$
$$\delta^{(r)}_n \equiv \Omega_n(E^r s) - \Omega_n(s) = (f*E^{r-1}(\Delta s))_n + \sum_{j=1}^{r-1} \delta^{(j)}_n , \quad r \geq 2 .$$

(ii) (setting $s = f$)

(a) $\Delta s = \Delta f = E^{-1} f$ ; $(f*\Delta^r f)_n = (f*E^r f)_{n-r}$ .

(b) $(f*f)_n = f_n + (f*Ef)_{n-1}$

(c) $\Omega_n(E^r f) = \Omega_n(E^{r-2} f) + \Omega_n(E^{r-1} f)$ , $r > 2$ , with
$\Omega_n(E^r f) = (f*f)_n$ when $r = 0$ , and
$= (f*f)_n + (f*f)_{n-1}$ when $r = 1$ .

(iii) (corollary of (ii)(c), writing $\Omega_{n,r}$ for $\Omega_n(E^r f)$)

$$\Omega_{n,r} = (f*f)_n f_{r+1} + (f*f)_{n-1} f_r , \quad r \geq 1 .$$

The proofs of (i), (ii) and (iii) require only simple algebra and Fibonacci number identities.

The final demonstration of the use of convolution trees, to display representations of integers, requires a section of its own.

## 3. On Fibonacci representations of the integers

A sequence of positive integers $\{s_1, s_2, \ldots\}$ is said to be *complete* with respect to the positive integers if and only if every integer $n \in Z^+$ can be represented as the sum of a finite number of distinct members of the sequence.

Hoggatt [4] gives nine basic theorems relating to representations of the integers by sequences. In particular he shows that with $n \geq 1$ the sequences $2^n$ , $f_n$ (Fibonacci), $u_n = f_{n+1}$ , and $l_n$ (Lucas) sequences are complete. Theorem VI in [4] (see also [3] for proofs, extensions and applications) is known as Zeckendorf's theorem. It states that every positive integer can be represented as the sum of distinct numbers in the sequence $u_n = f_{n+1}$ using no two consecutive Fibonacci numbers; and furthermore, such a representation is unique.

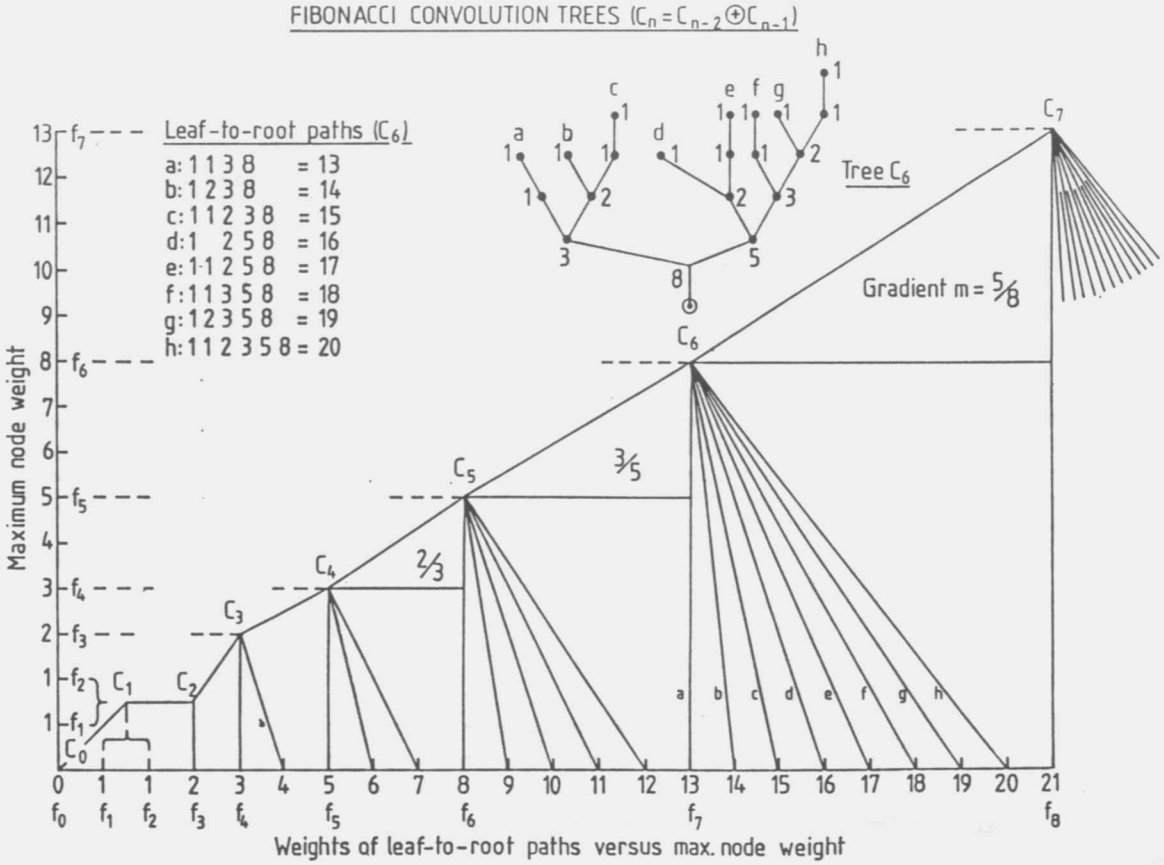
We now show how the Fibonacci convolution trees can provide constructive proofs of some of these representation theorems.

Consider the set of all leaf-to-root paths in a given convolution tree. Each leaf node determines a unique path, say $p_i$ . We can label the paths $p_1, p_2, \ldots, p_g$ , according to their position (taken from left to right) on the tree diagram. Now let us add up the node weights on path $p_i$ (i.e. obtain the sum $\Omega(p_i)$) and denote this *path weight* by $\omega_i$ . This produces a sequence $\{\omega_1, \omega_2, \ldots, \omega_g\}$ which we will call the *shade* of the tree (the diagram below makes it clear why that name was chosen).

It is a remarkable fact (we were astounded when we first added up the path weights!) that if the set of weights assigned to the convolution trees is the Fibonacci sequence, then each tree shade is a subsequence, in natural order, of the positive integers. Further, the union of the shades of trees $C_1, C_2, \ldots, C_n$ is the integer sequence $1, 2, 3, \ldots, f_{n+2} - 1$ (with no repetitions).

Thus a convolution tree with Fibonacci weights at once demonstrates the completeness of the Fibonacci sequence, and provides an algorithm for writing down a Fibonacci representation for any integer $N$ . This latter is so because to each $N$ there corresponds a path $p_i$ in some tree $C_j$ , and all the weights on the nodes of $p_i$ are distinct Fibonacci numbers which sum to $N$ . Note that if $f_j \le N < f_{j+1}$ , and $N - f_j = k$ , the required path is the $(k+1)^{th}$ path from the left in tree $C_j$ .

It is time to present one of the 'proofs by picture' which were promised in the introductory remarks. The following diagram 'tells all' about the integer representation just discussed. We offer it as a good example of serendipitous mathematical art.



Proofs

Proofs of formulae (i)-(iv) and (vi), (vii) follow easily from elementary graph theorems, Fibonacci identities, and the recursive manner of construction of the tree.

Formula (v) is of special interest, being the reason for the name we have given the trees. Its validity may be checked by noting that sums of node weights satisfy the equation

$$\Omega(C_n) = \Omega(C_{n-2}) + \Omega(C_{n-1}) + s_n \ .$$

This follows from the recursive construction of $C_n$. Then it may be directly checked that $(f*s)_n$ is a solution to this recurrence equation, with initial values $s_1$ and $s_1 + s_2$.

An interesting corollary of (iv) and (viii) is that

$$f_n = \sum_m \binom{m-1}{n-m} \ , \text{ with } m \text{ varying from } \left\{\frac{n}{2}\right\} \text{ to } n \ .$$

The alert reader will suspect that Pascal's triangle is lurking in the background to this one, and he or she will be correct. If a two-way table is drawn up tabulating the number of leaf-nodes at level $m$ horizontally, versus tree subscript $n$ vertically, a strangely shaped Pascal's triangle appears, hanging from the leading diagonal. Binomial coefficients occur in the columns, and row sums are the Fibonacci numbers. Thus the convolution tree sequence demonstrates this well-known identity relating the two kinds of number.

## 2. Uses of the convolution trees

Weighted Fibonacci trees are structured configurations of integers, and in the long tradition of such structures (c.f. figurate numbers, Ferrer's diagrams in partition theory, and the like) they can be used to reveal identities between well-known types of number, and also to demonstrate special kinds of partitions of numbers in given sequences.

Further, the set of weights $s$ can be regarded as a variable, and attempts can be made to obtain, with the help of the trees, general identities or relationships between $f$ and $s$.

Simple examples of both these approaches will now be given. The final section of the paper will demonstrate the use of the trees for studying representations of the integers by Fibonacci numbers.

Example 1 (given above) $\quad f_n = \sum_m \binom{m-1}{n-m} \ .$ (Lucas, 1876)

Example 2 We will state this result as a theorem, then follow it with a diagram which illustrates the result and indicates the key to the proof.

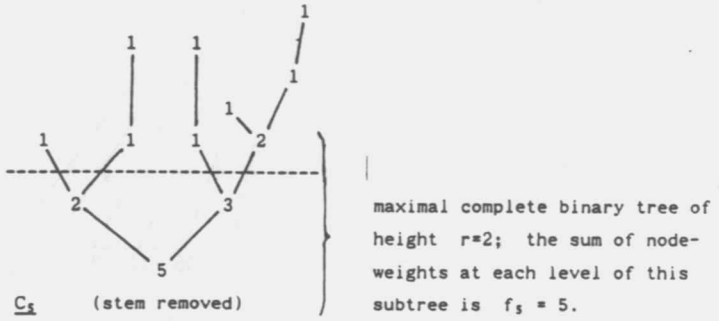
Theorem

Let $c_j = (f*f)_j$, and $r = \left\{\frac{n}{2}\right\} - 1$ (where $\{x\}$ means the smallest integer $\geq x$).

Then $rf_n = c_n - \sum_{i=0}^{r} \binom{r}{i} c_{i+1}$, $n \geq 3$.

Proof (by diagram)

The set of weights used in the convolution tree is $f$, the Fibonacci numbers. The key to the proof is that every convolution tree contains a maximal complete binary tree, whose leaf-nodes support lower order convolution trees (these are without their roots and stems). A diagram of $C_5$ illustrates this. In the proof we partition the diagram at the dotted line. The subtrees supported by the complete binary tree are distributed with binomial coefficient frequencies.




$C_5$ (stem removed)

Remarks on the diagram

Can we obtain anything more from the diagram?

First we observe that every leaf node has weight $f_1 = 1$ . So every integer representation obtained from the convolution trees includes $f_1$ : removing it from each gives a representation of the integer sequence $\{2, 3, 4, \ldots\}$ ; thus the diagram also establishes the completeness of the sequence $u_n = f_{n+1}$ (we let $u_1$ represent 1 ).

Next we may note interesting properties of the path lengths, and the integer representations the paths provide. We discuss these points in [5]; here we give just two theorems on the matter, without proof or further discussion.

Theorem (on path and shade weights)
Given a Fibonacci convolution tree $C_k$ , with Fibonacci weights $f$ , then;

(i) The maximum and minimum path lengths are respectively $k$ and $\left[\frac{k}{2}\right] + 1$ ;

(ii) The maximum and minimum path weights are respectively $f_{k+2} - 1$ and $f_{k+1}$ ;

(iii) Denoting by $Z_k$ the shade of $C_k$ , the weight of the shade is
$\Omega(Z_k) = \sum_{i=1}^{f_k} \omega_i = \frac{1}{2} f_k(f_{k+3} - 1)$ ;

(iv) The sum of the shades of the first $r$ trees is equal to $\frac{1}{2} f_{r+2}(f_{r+2} - 1)$ ;

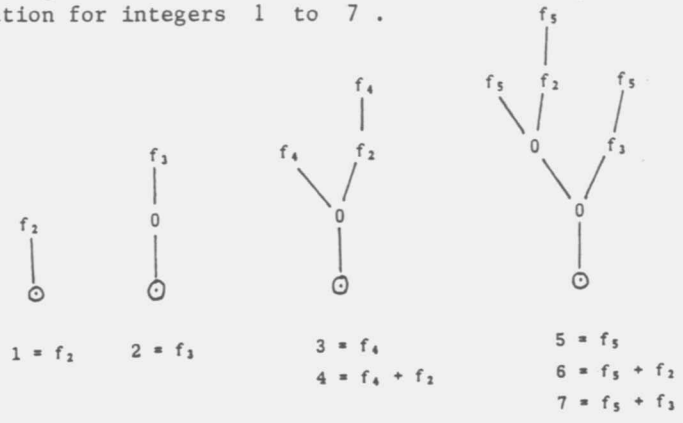
(v) From (iii) and (iv) we get the identity $\sum_{k=1}^{r} f_k(f_{k+3} - 1) = f_{r+2}(f_{r+2} - 1)$ .

Theorem (on the integer representation)
Let $N$ be any integer in the interval $[f_j, f_{j+1})$ . Then $N$ has a representation consisting of $r$ distinct Fibonacci numbers with $r$ in the range $\left[\frac{j-1}{2}\right] + 1$ to $(j - 1)$ inclusive.

Finally we turn to Zeckendorf's theorem, and ask whether convolution trees can be used to prove it. We present below a sequence of weighted trees which provide a Zeckendorf representation for each integer in their shades. The diagrams, of course, cannot demonstrate the uniqueness of the representations; but the construction rules inductively ensure it can be done for every integer.

The set of weights used is $u$ together with $0$ , i.e. $\{0, f_2, f_3, \ldots\}$ ; and a modified drip-feed principle has to be used when introducing the weights to the tree sequence. We define the principle, and discuss other results relating to convolution trees and integer representations, in [5].

The following diagram shows the first four Zeckendorf-weighted trees, giving the required types of representation for integers 1 to 7 .



Notice that no path contains two consecutive Fibonacci numbers. That is Zeckendorf's requirement.

REFERENCES


1. Y. Horibe. *Notes on Fibonacci Trees and their Optimality.* The Fibonacci Quarterly, Vol. 20, No. 2, pp. 168-178, 1982.
2. J.C. Turner & B. Beder. *Stochastic Processes defined on Tree Sequences,* (submitted to Fib. Qtly., Feb. 1985).
3. J.L. Brown Jr. *Zeckendorf's Theorem and some Applications.* The Fibonacci Quarterly, Vol. 2, No. 3, pp. 163-168, Oct. 1964
4. V.E. Hoggatt Jr. *Fibonacci and Lucas Numbers.* Houghton Mifflin Coy., 1969.
5. J.C. Turner. *On Tree Sequences with Given Node Properties.* Research Report, University of Waikato (in preparation February, 1985).


# Problems

Sub-edited by A. Zulauf, University of Waikato

*PROPOSALS of problems should be sent to the sub-editor and should be accompanied by solutions and/or relevant references, comments, etc.*

*SOLUTIONS should be sent to the sub-editor within three months from the publication of each problem. If you discover that a problem has already been mentioned or solved in the literature, please send full details to the sub-editor.*

*************

Problem 16 (*A Diophantine equation*)

Find all solutions in positive integers $n$, $x$, $m$, $y$ of the equation

$$n(nx^3 - 1) = m(my^3 - 1) \quad \text{with} \quad n < m.$$

Failing this, prove or disprove that there are infinitely many such solutions.

Failing this, try to find solutions other than the five given by

$(n, x, m, y) = (2, 2, 6, 1), (1, 5, 4, 2), (3, 3, 16, 1), (1, 17, 19, 1), (3, 5, 34, 1).$

*Sub-Editor*

Partial Solution to Problem 14 (*A question of bounds*)

Let $Z$ range over all sequences $(z_1, z_2, \ldots)$ of numbers in the set $\{z \in \mathbb{C} : |z| \leq 1\}$, let $X_p$ range over all sequences $(x_1, x_2, \ldots)$ of vectors in the set $\{x \in \mathbb{R}^p : |x| \leq 1\}$, let $E$ range over all sequences $\{\varepsilon_1, \varepsilon_2, \ldots\}$ of numbers in the set $\{-1, +1\}$, and let

$$S_n = S_n(Z,E) = \sum_{j=1}^{n} \varepsilon_j z_j \; ; \qquad K = \sup_{Z} \inf_{E} \sup_{n \geq 1} |S_n| \; .$$

(a) The solution of part (a) is contained in the following, more general result

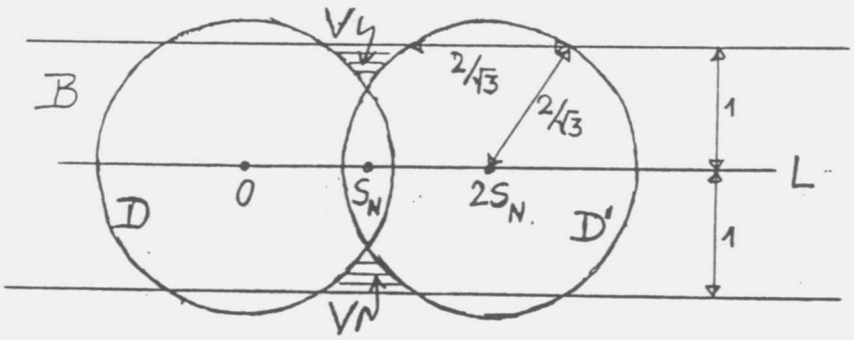
proved by the proposer, B. Aubertin of Massey University:

$$\sup_{X_p} \inf_{E} \sup_{n\geq 1} \left| \sum_{j=1}^{n} \varepsilon_j x_j \right| = K_p \leq 2^{p-1} .$$

His proof is based on an argument used by N.S. Jeans and T. Moore (also of Massey University) for the case $p = 2$ $(K = K_2 \leq 2)$, an outline of which follows. The statement (*) below is true for $n = 1$ with the choice $\varepsilon_1 = 1$.

(*) $\{\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_n\} \subseteq \{-1, 1\}$, $|S_n| \leq \frac{2}{\sqrt{3}}$, $\sup_{1\leq k<n} |S_k| \leq 2$.

Suppose $\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_N$ have been so chosen that (*) is true for $n = N$, $N \geq 1$. If $|S_N| \leq \frac{1}{\sqrt{3}}$ then clearly $\varepsilon_{N+1}$ can be so chosen that (*) is true for $n = N+1$. Assume now that $|S_N| > \frac{1}{\sqrt{3}}$. Let $D$ and $D'$ be the discs $\{z : |z| \leq \frac{2}{\sqrt{3}}\}$ and $\{z : |z - 2S_N| \leq \frac{2}{\sqrt{3}}\}$, let $L$ be the straight line $OS_N$, let $B$ be the strip $\{z : \mathrm{dist}(z,L) \leq 1\}$ and let $V$ consist of the two bounded components of $B - (D \cup D')$ (shaded in the diagram).




Choose, as is clearly possible, $\delta_1, \delta_2, \ldots$ so that

$$T_k = S_N + \sum_{j=1}^{k} \delta_j z_j \in B \quad \text{for } k = 1, 2, \ldots$$

Note that $T_1 \in D \cup D' \cup V$, and that if $T_k \in V$ then $T_{k+1} \in D \cup D' \cup V$. Note also that $V \subseteq \{z : |z| \leq r\}$ where $r = \sqrt{\{1 + (2S_N - \frac{1}{\sqrt{3}})^2\}} \leq 2$. Hence, if $T_k \in V$ for all $k \geq 1$ then the choice $\varepsilon_{N+k} = \delta_k$ will give $|S_{N+k}| \leq 2$ for all $k \geq 1$. Otherwise let $M$ be the smallest positive integer for which $T_M \notin V$, and (*) will be true for $n = N + M$, with the choice $\varepsilon_{N+j} = \delta_j$ or $= -\delta_j$ $(1 \leq j \leq M)$ according as $T_M \in D$ or $\in D'$.

(b) Part (b) of the problem has not been solved yet. We know from part (a) that $K \leq 2$. On the other hand, N.S. Jeans of Massey University found the

following example to show that $K \geq \sqrt{3}$. Let $0 < \varepsilon < 1$, $z_1 = 1$, and if $z_1, z_2, \ldots, z_m$ have been chosen, put $t_m = z_1 + z_2 + \ldots + z_m$ and choose $z_{m+1}$ so that $|t_m - z_{m+1}| = \sqrt{(3 - \varepsilon)}$. It is easily seen that $|t_m|^2 > 2^{m-1}\varepsilon$, and the process stops when $m = M$ where $|t_{M-1}| < \sqrt{(3-\varepsilon)} \leq |t_M|$. Whatever the choice of $E$, at least one of $|S_1|, |S_2|, \ldots, |S_M|$ will be $\geq \sqrt{(3-\varepsilon)}$.

(c) The solution of part (c) is given by $C = \sqrt{2}$, where

$$C = \sup_{Z} \sup_{n \geq 1} \min_{E} |S_n|.$$

The example $Z = (1, i, 0, 0, \ldots)$ shows that $C \geq \sqrt{2}$. To prove that $C \leq \sqrt{2}$, let $\varepsilon_{1,1} = 1$, $I_1 = \{1\}$, $J_1 = \emptyset$ and prove by induction on $n$ that, given $Z$, there exist $\{\varepsilon_{n,1}, \varepsilon_{n,2}, \ldots, \varepsilon_{n,n}\} \subseteq \{-1, 1\}$ and a partition of $\{1, 2, \ldots, n\}$ into subsets $I_n$ and $J_n$ such that

$$S_n = a_n + b_n \; ; \quad a_n = \sum_{j \in I_n} \varepsilon_{n,j} z_j \; ; \quad b_n = \sum_{j \in J_n} \varepsilon_{n,j} z_j ;$$

$$|a_n| \leq 1, \quad |b_n| \leq 1 \quad \text{and} \quad |S_n| \leq \sqrt{2}.$$

To do so, note that if the moduli of three complex numbers $a$, $b$, $z$ are all $\leq 1$, then the modulus of at least one of the six numbers $a \pm b$ $a \pm z$, $b \pm z$ must be $\leq 1$, and the modulus of at least one of the two numbers $a \pm b$ must be $\leq 1$.

STOP PRESS

It appears that the Massey team have cracked problem 14(b) by showing that $K = \sqrt{3}$, but their proof arrived too late to be considered for this issue of the Newsletter.

*Sub-Editor*

Comments on Problem 15 *(3816547890 and all that)*

Little progress has been made with this problem, i.e. to determine the number, $N(b)$, of positive integers $n$ with the property, $P(b)$, that their representation $n = a_{b-1}a_{b-2} \cdots a_1 a_{0(b)}$ contains all $b$ digits and $k | a_{b-1}\, a_{b-2} \cdots a_{b-k(b)}$ for $k = 1, 2, \ldots, b$. The proposer, D.B. Gauld of Auckland, tells me that $N(12) = 0$, $N(30) = 0$, and (if his computer programme is correct) $N(14) = 1$, the integer with property $P(14)$ being

9 12 3 10 5 4 7 6 11 8 1 2 13 0.

*Sub-Editor*

# Conferences

*Compiled by Dr M.R. Carter, Massey University*

***1985***

May 5-11 (Varna, Bulgaria)
*Third International Conference on Complex Analysis and Applications*
Details from T. Tonev, Institute of Mathematics, Bulgarian Academy of Sciences, P.O. Box 373, 1090 Sofia, Bulgaria.

May 6-8 (Providence, Rhode Island)
*Seventeenth Annual ACM Symposium on Theory of Computing*
Details from Patrick W. Dymond, Publicity Chairman, SIGACT-85 Symposium, Department of Electrical Engineering and Computer Sciences, University of California, San Diego, La Jolla, California 92093, U.S.A.

May 13-17 (Sydney)
*Third Australasian Mathematics Convention*
Details from Dr J.F. Price, School of Mathematics, University of New South Wales, P.O. Box 1, Kensington, New South Wales 2033, Australia.

May 15-17 (Lindfield, New South Wales)
*Third Australian Symposium on Stereology and Image Analysis*
Details from Dr N. Wreford, c/- Anatomy Department, Monash University, Clayton, Victoria 3168, Australia.

May 16-21 (Berkeley, California)
*Workshop on Differential Geometry*
Details from Mathematical Sciences Research Institute, 2223 Fulton Street, Room 603, Berkeley, California 94720, U.S.A.

May 17-19 (Minneapolis, Minnesota)
*Conference on the History and Philosophy of Modern Mathematics*
Details from William Aspray, Charles Babbage Institute, 104 Walter Library, 117 Pleasant Street SE, University of Minnesota, Minneapolis, Minnesota 55455, U.S.A.

May 20-23 (Pau, France)
*15th Journées de Statistique*
Details from Laboratoire de Statistique et Probabilités, Dépt. de Math., Faculté des Sciences, Avenue de l'Université, 64000 Pau, France.

May 20-24 (Auckland)
*Pacific Statistical Congress*
Details from the Committee Secretary, Pacific Statistical Congress, Department of Mathematics, University of Otago, P.O. Box 56, Dunedin, New Zealand.

May 20-24 (Los Alamos, New Mexico)
*Fifth Annual Conference on Evolution, Games and Learnings: Models for Adaptation in Machines and Nature*
Details from Centre for Nonlinear Studies, MS B258, Los Alamos, National Laboratory, Los Alamos, New Mexico 87545, U.S.A.

May 23-June 1 (Berkeley, California)
*Workshop on Four-Manifolds and Geometry*
Details from Mathematical Sciences Research Institute, 2223 Fulton Street, Room 603, Berkeley, California 94720, U.S.A.

May 26-June 2 (Jachranka, Poland)
*International Conference on Functional-Differential Systems and Related Topics IV.*
Details from Danuta Przeworska-Rolewicz, Mathematical Institute, Polish Academy of Sciences, Sniadeckich 8, 00-950 Warsaw, Poland.

May 28-June 1 (Montréal, Canada)
*Colloque de Combinatoire Énumérative*
Details from Pierre Leroux, Département de mathématiques et d'informatique, Université du Quebec à Montréal, C.P. 8888, succ.A, Montréal, Québec, Canada H3C 3P8.

June 5-14 (Berkeley, California)
*Conference on Geometry and Operator Algebras*
Details from Mathematical Sciences Research Institute, 2223 Fulton Street, Room 603, Berkeley, California 94720, U.S.A.

June 10-14 (New York)
*Third International Conference on Combinatorial Mathematics*
Details from Conference Director, New York Academy of Sciences, 2 East 63rd Street, New York, New York 10021, U.S.A.

June 10-14 (Stockholm)
*Seventh International Symposium on the Mathematical Theory of Networks and Systems*
Details from MTNS-85, c/- Stockholm Convention Bureau, Box 1617, S-111 86 Stockholm, Sweden.

June 10-15 (Singapore)
*Conference on Topology*
Details from John Berrick, Department of Mathematics, National University of Singapore, Kent Ridge 0511, Republic of Singapore.

June 19-21 (Dublin)
*Fourth International Conference on the Numerical Analysis of Semiconductor Devices and Integrated Circuits*
Details from NASECODE Organising Committee, Doole Press Limited, P.O. Box 5, 51 Sandycove Road, Dun Laoghaire, Co. Dublin, Ireland.

June 20-July 5 (Lecce, Italy)
*Third Workshop on Nonlinear Evolution Equations and Dynamical Systems*
Details from Marco Boiti, Dipartimento di Fisica, Università di Lecce, via Arnesano, 73100 Lecce, Italy.

June 23-28 (Tübingen West Germany)
*Aspects of Positivity in Functional Analysis*
Details from Mathematisches Institut der Universität Tübingen, Auf der Morgenstelle 10, D-7400 Tübingen, Federal Republic of Germany.

July 1-5 (Durban, South Africa)
*International Conference on Classical and Categorical Algebra*
Details from K.A. Hardie, Department of Mathematics, University of Cape Town, Rondebosch 7700, Republic of South Africa.

July 1-6 (Palma de Mallorca, Balearic Islands)
*First International Fuzzy Systems Association Congress*
Details from R. López de Màntaras, Chairman, Organizing Committee, Universitat Politècnica de Catalunya, Facultat d'Informàtica, c/- Dulcet 12, Barcelona 34, Spain.

July 2-6 (Nagoya, Japan)
*Fifteenth Conference on Stochastic Processes and their Applications*
Details from T. Hida, Department of Mathematics, Faculty of Science, Nagoya University, Chikusaku, Nagoya, 464 Japan.

July 5-6 (Hamburg, W. Germany)
*International Colloquium on Applications of Mathematics*
Details from University of Hamburg, Institute of Applied Mathematics, Bundesstrasse 55, D-2000 Hamburg, 13, Federal Republic of Germany.

July 7-13 (Orsay, France)
*Logic Colloquium 85: European Summer Meeting of the Association for Symbolic Logic.*
Details from Colloque de Logique 85, U.A. 753, UER de Mathématique et Informatique, Université Paris VII, 2 Place Jussieu, 75252 Paris Cedex 05, France.

July 8-20 (Stanford, California)
*Conference on Logic, Language and Computation*
Details from Ingrid Deiwiks, Center for the Study of Language and Information, Ventura Hall, Stanford University, Stanford, California 94305, U.S.A.

July 16-19 (Exeter)
*Second International Conference on the Teaching of Mathematical Modelling*
Details from Sally Williams, Conference Secretary, University of Exeter, St. Lukes, Exeter, EX1 2LU, England.

July 22-26 (Glasgow)
*Tenth British Combinatorial Conference*
Details from I. Anderson, Department of Mathematics, University of Glasgow, Glasgow G12 8QW, Scotland.

July 27-August 3 (St. Andrews, Scotland)
*Groups 1985*
Details from C.M. Campbell, Mathematics Institute, North Haigh, St. Andrews, Fife, Scotland KY16 9SS.

July 28-August 10 (Kent, Ohio)
*Conference on Banach Spaces and Classical Analysis*
Details from Banach Space Conference, c/- Richard M. Aron and Joe Diestel, Department of Mathematics, Kent State University, Kent, Ohio 44242, U.S.A.

July 31-August 8 (Berkeley, California)
*Symposium on the Transmission of Mathematical Science*
Details from J. Dhombres, UER de Mathématiques, 2 rue de la Houssiniere, F-44072 Nantes Cedex, France.

August 5-9 (Poznań, Poland)
*Second Seminar on Random Graphs and Probabilistic Methods in Combinatorics*
Details from Michal Karoński, Institute of Mathematics, Adam Mickiewicz University, Matejki 48/49, 60-769 Poznań, Poland.

August 5-16 (Athens, Georgia)
*Georgia Topology Conference*
Details from Clint McCrory, Mathematics Department, University of Georgia, Athens, Georgia 30602, U.S.A.

| | |
|---|---|
| September 2-12 (Castelvecchio-Pascoli, Italy) | *NATO Advanced Study Institute: Advances in Microlocal Analysis* Details from H.G. Garnir, Department of Mathematics, University of Liege, 15, avenue des Tilleuls, B-4000 Liège, Belgium. |
| September 16-20 (Dusseldorf, West Germany) | *Sixth International Meeting on Clinical Biostatistics* Details from Dr R.A. Dixon, University of Sheffield Medical School, Beach Hill Road, Sheffield S10 2RX, United Kingdom. |
| September 17-19 (Madrid) | *International Symposium on Numerical Analysis* Details from Carlos Vega, Faculty of Computer Sciences, Polytechnical University of Madrid, Carretera de Valencia, km 7, Madrid 31, Spain. |
| October 7-12 (Bari, Italy) | *III Biennial Meeting on Waves and Stability in Continuous Media* Details from Prof. M. Maiellaro, Department of Mathematics, University Campus, Bari, Italy. |
| November 18-22 (Hamilton, New Zealand) | *International Symposium on Single and Multiphase Flow through Heterogeneous Permeable Materials* Details from IUTAM Symposium, Physics and Engineering Laboratory, D.S.I.R., Private Bag, Lower Hutt, New Zealand. |

***1986***

| | |
|---|---|
| July 27-August 1 (Seattle, Washington) | *Thirteenth International Biometric Conference* Details from Gerald van Belle, Dept. of Biostatistics, University of Washington, Seattle, Washington 98195, U.S.A. |
| August 3-11 (Berkeley, California) | *International Congress of Mathematicians* Details from ICM-86, P.O. Box 6887, Providence, Rhode Island 02940, U.S.A. |
| August 11-16 (Victoria, British Columbia) | *Second International Conference on Teaching Statistics (ICOTS 2)* Details from Professor T. Lietaer, University Extension Conference Office, University of Victoria, P.O. Box 1700, Victoria, British Columbia, Canada B8W 2Y2. |

# Notices

## MATHEMATICS PROJECT COMPETITION FOR TEACHERS

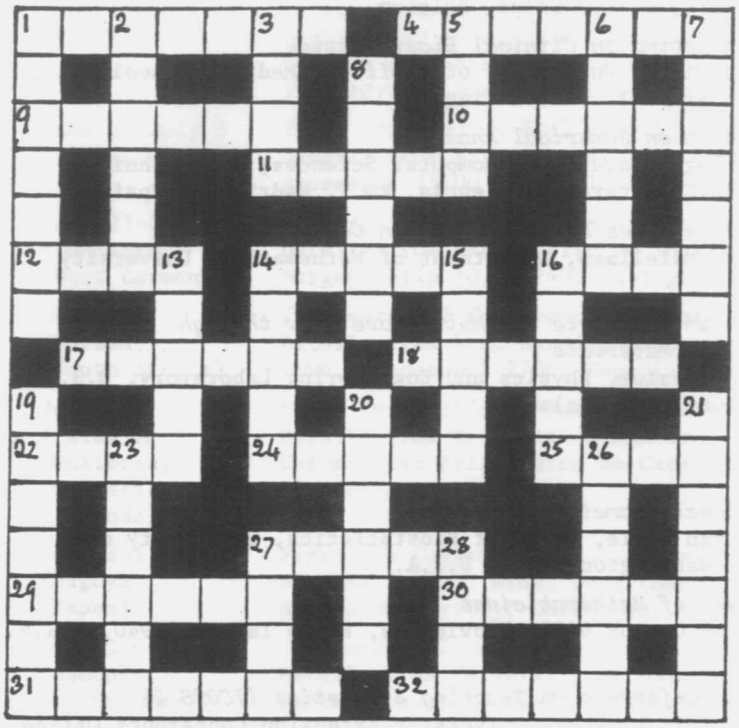
1. The competition is open to teachers of mathematics in New Zealand.
2. The project shall be on one of the following:
   (a) an application of mathematics in the community;
   (b) an application of mathematics in another discipline;
   (c) an aspect of the teaching of mathematics (e.g. novel or non-standard classroom techniques); or
   (d) the motivation and use of games in mathematics.
3. The mathematics involved should be no more advanced than in the seventh form mathematics syllabus.
4. The project should not have been published elsewhere and should preferably have an innovative or original aspect.
5. Projects will be judged on their originality and suitability for use in teaching mathematics.
6. The New Zealand Mathematical Society reserves the right to publish an account of any project received.
7. There will be three prizes of $250, $150 and $75.
8. Closing date: 1 June 1985. Results announced 21 September 1985.
9. Entries or enquiries should be directed to Mr T.A. Wilson, P.O. Box 6855, Auckland.

## CORRECTION TO LIST OF RSNZ FELLOWS

In the centrefold on Professor John Butcher in Newsletter No. 18 (August 1980) there was given a list of six "mathematicians" who were Fellows of the Royal Society of New Zealand. It should be recorded that Professor R.H.T. Bates of the Department of Electrical and Electronic Engineering at Canterbury University, who has been a member of the NZMS since its foundation, is also a Fellow of the Royal Society of New Zealand and the omission of his name from the original list is regretted.

# Crossword

No. 16 2 DOWN'S PLAYTIME by Matt Varnish



Across:

1 and 4 across. Western childhood protagonists (7,7).
9. An Irish use of sticks (6).
10. Skittles sky ale in the game (6).
11. Game described by Pope (5)
12. It could be left or right but not straight (4)
14. Game of 32 on 64 (5)
16. Part of verb to issue from flower holder (4)
17. Distract as the game would Diana on the green (6)
18. Mask could be blank blank (6)
22. Move at large from the game of mora (4)
24. A kind of shooting ekes out to the epitome of suitability (5)
25. Whist for one (4)?
27. Z (3,2)
29. The doctor in the storm is an uncertain investment (6).
30. With hot reassemble fares anew (6)
31. Dashes; are they dabs from the southpaw (7)?
32. see 21 down.

Down:

1. Turn torch so classic groups appear (7).
2. The operator who is not playing (6).
3. Stringed object for swinger (4).
5. Nasty verb of the modern war-game (it is Greek to start) (4).
6. Extreme effort is complete dismissal (3,3).
7. Perhaps used by those who 29 being in Messy St. (7).
8. Elastic bridge term (6).
13. Dice game for five (5).
14. Play things including double-headed royalty (5).
15. 9 is one south to left (5).
16. There are 4 in 14 and school has all in short (5).
19 and 20 down. Musical fruits (7,6).
21 and 32 across. The ox's game (7,7).
23. Poetical returning bird of baseball (1,6)?
26. Routes around on target (6).
27. To try an international game (4).
28. One with equality is two (4).

CROSSWORD No.15 SOLUTION

Across:

1. Nebula,
8. Charge,
10. Quality,
11. Cubes,
12. Abel,
13. Kerala,
16. Fermat,
17. Ones,
20. Gauss,
21. Thought,
22. Anklet,
23. Settle.

Down:

1. Unequal,
2. A brace of ducks,
3. Elvis,
4. The Crab,
5. Arabian Nights,
6. Beast,
9. Typecasts,
14. Presley,
15. Tse-tses,
18. Ogham,
19. Loved.

The Newsletter is the official organ of the New Zealand Mathematical Society. It is produced in the Mathematics Department of the University of Otago and printed at the University Printery. The official address of the Society is:

New Zealand Mathematical Society (Inc.)
C/- The Royal Society of New Zealand
Private Bag
WELLINGTON

However correspondence should normally be sent direct to the Secretary, Dr C.H.C. Little, Department of Mathematics and Statistics, Massey University, Palmerston North.