2014/15

AMSI Summer School

The University of Newcastle
5–29 January 2015

AMSI
AUSTRALIAN MATHEMATICAL SCIENCES INSTITUTE

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

Australian Government
Department of Education and Training

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Summer School

The University of Newcastle, 5 – 29 January 2015

2015


AMSI
AUSTRALIAN MATHEMATICAL
SCIENCES INSTITUTE
National
Collaboration
in the Mathematical
Sciences
www.amsi.org.au

01

Introduction

The AMSI Summer School in the Mathematical Sciences is one of the flagship events on the Australian mathematical calendar, and the University of Newcastle, in it's 50th year, was proud to host the event for the first time.

This year, 107 students from across Australia attended the Summer School which ran from the 5th to the 29th of January. Taking one or two of the eight Honours-level courses on offer, students were taught by some of the best researchers and teachers of mathematics in Australia. Courses were offered in pure and applied mathematics, statistics, as well as, control theory and statistical mechanics. These intensive courses were supplemented by a series of lunctime lectures on subjects which extended the material of the courses, numerous social events, a careers afternoon, a cv workshop and a public lecture.

The program committee gave invaluable help in putting together the educational program of the Summer School. The local organising committee were tireless in their efforts to help deliver a successful and memorable Summer School. I am indebted to all of them. In particular, Juliane Turner was of tremendous help with matters of finance and organisation and devoted many hours to make sure the school ran smoothly. Numerous University of Newcastle PhD students and undergraduates gave great support at social events, and I thank them all.

The staff of AMSI, including Professor Geoff Prince, Simi Henderson and Joanna Wilson, were extremely helpful, supportive and, above all, patient. Thanks must also go to Associate Professor Stephen Roberts – Director of the 2014 AMSI Summer School – who answered numerous questions and gave invaluable advice right through the process.

The Summer School lecturers (12 in all) were thoroughly professional, enthusiastic and accommodating, and gave outstanding courses. It was a pleasure to work with all of them.

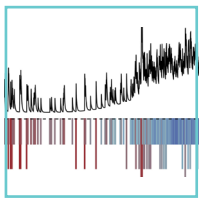
Finally, to the students who came to Newcastle from far and wide – thanks for coming, and we hope to see you here again before too long.

Dr Jeffrey Hogan
Director, 2015 AMSI Summer School

Subjects

02

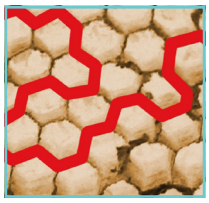
Eight honours level subjects were offered at the AMSI Summer School, students had the opportunity to take one or two of the subjects for credit towards their Honours or Masters degree.



COMPUTATIONAL BAYESIAN STATISTICS

Dr Chris Drovandi,
Queensland University of Technology

Dr Gentry White,
Queensland University of Technology



MATHEMATICAL STATISTICAL MECHANICS

Professor Jan De Gier,
The University of Melbourne

Dr Nathan Clisby,
The University of Melbourne

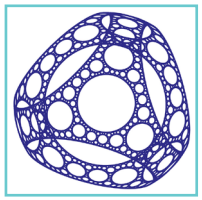
Dr Tim Garoni,
Monash University

CONTINUED FRACTIONS

Professor Wadim Zudilin,
The University of Newcastle

INTRODUCTION TO NONLINEAR PDE

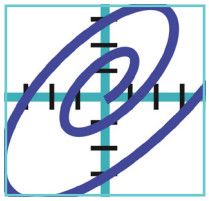
Dr Mike Meylan,
The University of Newcastle



GEOMETRIC GROUP THEORY

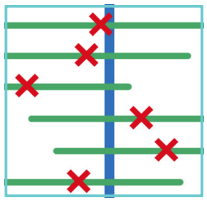
Dr Murray Elder,
The University of Newcastle

Dr Lawrence Reeves,
The University of Melbourne



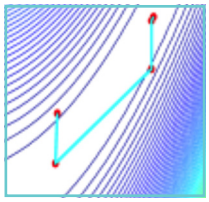
NONLINEAR CONTROL THEORY

Dr Zhiyong Chen,
The University of Newcastle



INTERMEDIATE PROBABILITY

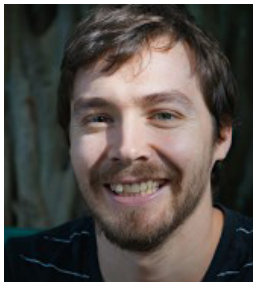
Professor Louise Ryan,
University of Technology Sydney



OPTIMISATION

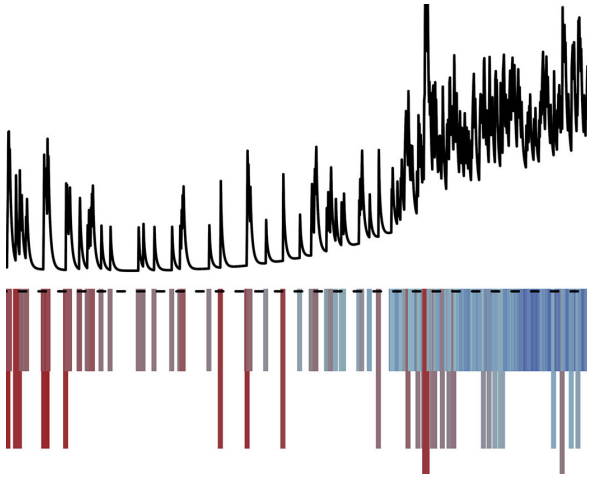
Associate Professor Regina Burachik,
University of South Australia

02.1 Subjects - *Computational Bayesian Statistics*



Dr Chris Drovandi,
Queensland University of Technology

Dr Gentry White,
Queensland University of Technology



As the complexity of statistical models grows to more accurately capture the behavior of real processes in many scientific fields, so has the need for developing associated computational algorithms so that these models can be calibrated against observed data. This subject introduced students to basic and advanced computational statistics algorithms with the focus on solving problems in Bayesian statistics. In addition, this subject gave students the opportunity to improve their scientific programming skills.

Course content

The content of this unit consisted of the basic principles and concepts required in various computational statistics algorithms. In addition, a suite of stochastic computational methods were presented in order to sample from high dimensional probability distributions and estimate high dimensional integrals. A major focus of the unit was sampling from the posterior distribution in Bayesian statistics.

The content was split into three main parts:

- Part I – Concepts in Computational Statistics and Introduction to Monte Carlo Methods
- Part II – Markov chain Monte Carlo Methods
- Part III – Sequential Monte Carlo and Approximate Bayesian Computation Methods

Lecturers' Comments

The students seemed to grasp the concepts well and were interested in the material. Most of the students were happy with the programming aspect of the course. The assignments were done well but the exam posed more of a challenge for the students. We feel this unit has been a good experience for both the students and the teaching staff as evidenced by the positive feedback.

"MATLAB based assignments were a logical way to teach the subject matter. Chris Drovandi was a fantastic lecturer, very helpful, and enthusiastic."

Summer School 2015 Participant

Professor Wadim Zudilin,
The University of Newcastle

Continued fractions are an aged child of the queen of mathematics, number theory and the king of mathematics, analysis. The summer course served as a semi-classical introduction into the subject with emphasis on the theory of both regular and irregular continued fractions and their applications to metric number theory, diophantine equations and equations,and special functions.

Course content

The following topics were covered during the course:

- Preliminaries from number theory
- Regular continued fractions
- Pell's equation
- Metric number theory
- Irregular continued fractions
- Irrationality of π^2 and other applications

Lecturers' Comments

I have had quite a positive experience teaching and socialising at the AMSI Summer School. There was fantastic local organisation of the Summer School by Jeff Hogan and Murray Elder.

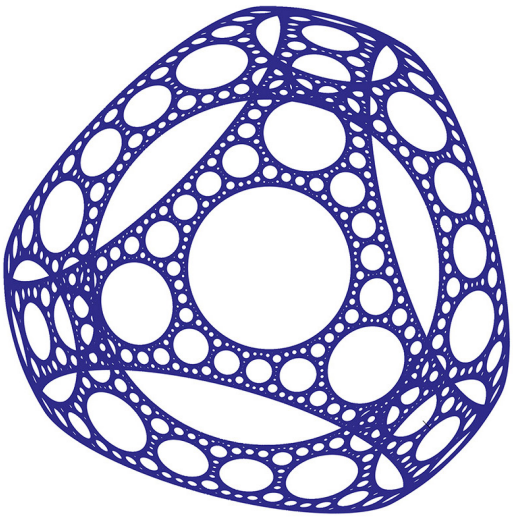
I definitely like the overall idea to socialise during the school and build up new relationships between the students, as well as, between the students and their teachers. Interactions during those social activities were very fruitful for making unofficial consultations and getting feedback from the students. The public lectures were well thought out this year and praised by the students.

"I enjoyed the challenging nature of the content and the assignments."

Summer School 2015 Participant

Dr Murray Elder,
The University of Newcastle

Dr Lawrence Reeves,
The University of Melbourne



Groups and geometry are ubiquitous in mathematics. This course introduced students to the study of infinite groups from the geometrical viewpoint and drew on ideas from low dimensional topology and from hyperbolic geometry. The principal focus was the interaction of geometry/topology and group theory: through group actions and suitable translations of geometric concepts into a group theoretic setting.

Course content

The following topics were covered during the course:

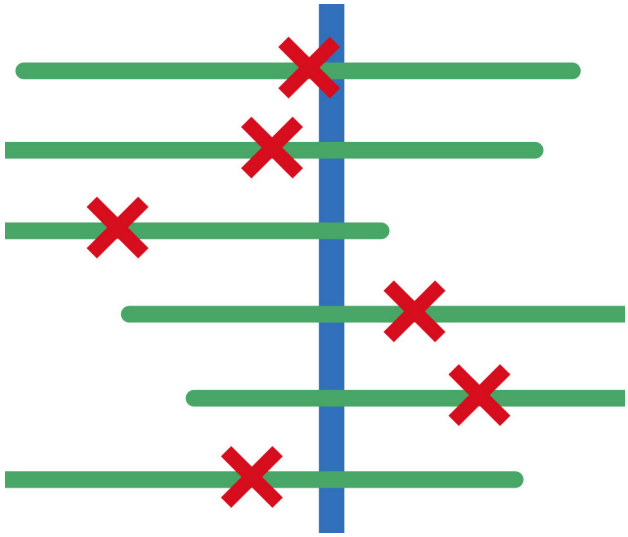
- Free groups, presentations
- Decision problems
- Cayley graphs, word metrics and coarse geometry
- Hyperbolic groups
- Automatic groups
- Automata groups

> The course was well received, fun to present, and we would be happy to give it again, especially now that we have put together a nice set of course notes.
>
> Summer School 2015 Participant

Lecturers' Comments

The majority of students seemed to really enjoy the course content and interacted well with the lectures, course notes and exercises. Sharing the course between two lecturers worked well for us. We alternated presenting each lecture, prepared the course notes and problems together (proofreading each other's contributions) and attended lectures when not presenting. The students were able to see two collaborators working together and helping each other when we got stuck, which we think is a positive model for them on how research mathematics really works.

Professor Louise Ryan,
University of Technology Sydney



Probability theory is the foundation of modern statistical science. This course went beyond introductory concepts to provide students with a sound working knowledge of multivariate distributions, moment generating and characteristic functions, convergence theory and Poisson processes.

Course content

The following topics were covered during the course:

- Multivariable Random Variables
- Conditioning
- Transforms
- Order Statistics
- Multivariable Normal Distribution
- Convergence
- Poisson Process

"The break from the normal lecture style of information delivery was good. I really enjoyed short discussions and working on problems with guidance from Louise."

Summer School 2015 Participant

Lecturers' Comments

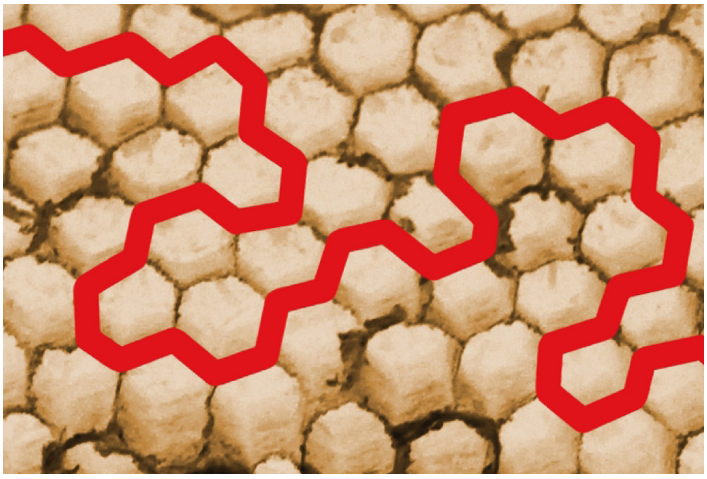
I taught the course in the so-called "flipped learning" style that has become very popular. Essentially this meant that I kept lectures to a minimum and class time was spent in active problem solving. This worked out beautifully. The students broke out into groups each class session to solve the problems and I would rotate around the groups, giving hints and comments, as well as regularly calling everyone's attention to make a more general point. I was very happy with how engaged the students seemed to be. Often they stayed after class, not just for 5 or 10 minutes, but for 30 minutes or more. It was exciting to see that level of engagement.

02.5 Subjects - *Mathematical Statistical Mechanics*

Professor Jan De Gier,
The University of Melbourne

Dr Nathan Clisby,
The University of Melbourne

Dr Tim Garoni,
Monash University



Statistical mechanics is a branch of mathematical physics which studies the emergent behaviour of large collections of interacting particles, using a probabilistic approach. This course focused on discrete models in statistical mechanics, in which the systems are defined on regular lattices. The main interest in these models stems from the fact that they display critical phenomena: macroscopic properties of the models change abruptly as a parameter is varied through a critical value. This course explored both two-dimensional systems, for which very precise results can often be proved, and three-dimensional systems, for which efficient approximation schemes provide the strongest type of solution that can be hoped for.

Course content

The following topics were covered during the course:

- Introduction to discrete models, including self-avoiding walks, Ising model, quantum XXZ spin chain and 6-vertex model, asymmetric exclusion process and percolation
- Introduction to phase transitions and critical phenomena
- Yang-Baxter integrability in two dimensions
- Combinatorial enumeration
- Markov chain Monte Carlo methods, including the pivot, worm and Swendsen-Wang processes
- The lace expansion
- Discrete holomorphic parafermions 8. Schramm-Loewner evolution (SLE)

Lecturers' Comments

Students found the course interesting and challenging. Most students had relatively little physics experience and appreciated getting a new perspective from taking a course that they would likely not have done without the AMSI Summer School environment.

We found this an enjoyable and interesting course to teach. The cohort of students had a far more varied background than would usually be the case for a mathematical physics course, but we found them to be bright and interested in the topic.

Dr Mike Meylan,
The University of Newcastle

This course was an introduction to nonlinear partial differential equations, focusing on nonlinear wave phenomena. We considered applications from physics, ocean engineering, chemical engineering, civil engineering and biology. The underlying partial differential equations were derived and the properties of the solutions investigated. Simulations of the PDEs were obtained using MATLAB.

Lecturers' Comments

I really enjoyed teaching this course and it was a great privilege to do so. The nature of the teaching meant that it was a very intense 3.5 weeks but I felt that the students tried hard and really engaged. They seemed to be enjoying themselves as well. The marks were distributed in a good fashion with a number of high marks and a good spread. I think that giving a challenging final exam worked well to distinguish the very good students. I hope that I get another opportunity to teach at the Summer School in the future.

"The practical skills and tools for solving PDEs are really handy for my future endeavours."

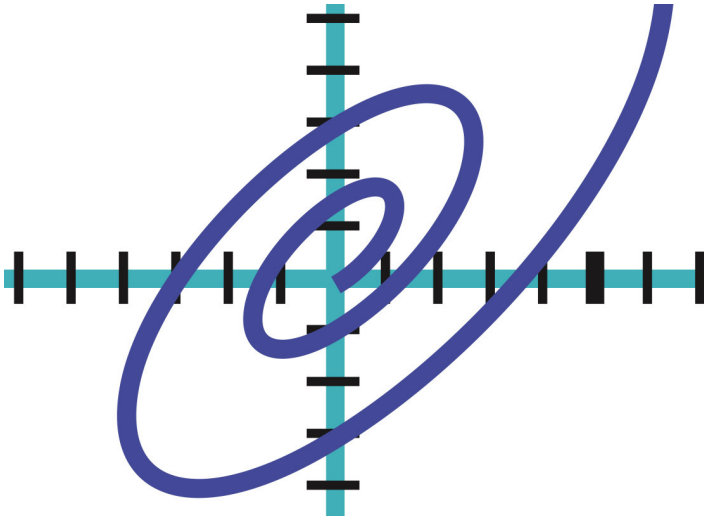
Summer School 2015 Participant

Course content

The following topics were covered during the course:

- Revision of the method of characteristics for linear partial differential equation.
- Traffic waves, solution using characteristics and shock dynamics
- Nonlinear shallow water waves or compressible gas dynamic waves. Solution by characteristics, the dam break problem, shock dynamics, hydraulic jumps and shallow water bores.
- KdV (Korteweg-De Vries) equation. Travelling wave solutions, solitary and cnoidal waves.
- Numerical solution of the KdV using the split-step method and computation of the soliton-soliton interaction.
- Conservation laws for the KdV and Miura's transformation.
- Introduction to the IST (Inverse Scattering transformation).
- Properties of the Linear Schrodinger equation
- The connection between the KdV and the Schrodinger equation.
- Example calculations for the KdV and IST
- Reaction-Diffusion systems.
- Burgers equation.

Dr Zhiyong Chen,
The University of Newcastle



The core of this course was a systematic and self-contained treatment of the nonlinear control theory for stabilisation and regulation problems. Its coverage embraced both fundamental concepts and advanced research outcomes and included many numerical and practical examples. Several classes of important uncertain nonlinear systems were discussed. The state-of-the-art solution presented uses of robust and adaptive control design ideas in an integrated approach. The course took advantage of rich new results to give students up-to-date instruction in the central design problems of nonlinear control, problems which are a driving force behind the furtherance of modern control theory and its application. The diversity of systems in which stabilisation and regulation become significant concerns in the mathematical formulation of practical control solutions makes the course relevant to students from a wide variety of backgrounds.

Course content

The course struck a balance between rigorous mathematical treatment and engineering practicality. The following topics were covered during the course:

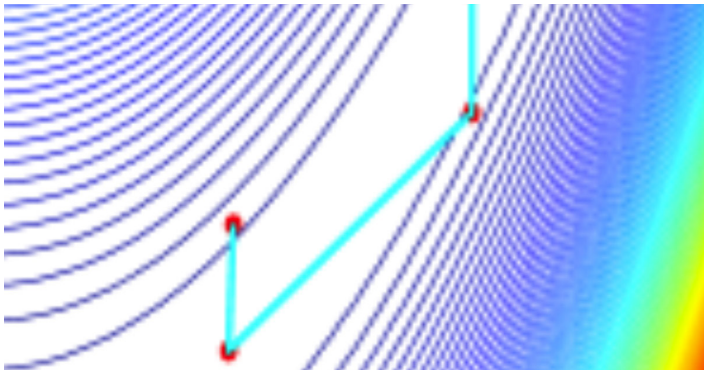
- Fundamentals of nonlinear systems, Lyapunov stability, robust stability, input-to-state stability, tools for adaptive control, changing supply function technique, small gain theorem
- Classification of nonlinear control systems, normal form, zero dynamics, lower triangular systems, output feedback systems
- Robust stabilisation theory, backstopping
- Adaptive stabilisation theory, tuning functions design
- Universal adaptive stabilisation theory
- Robust output regulation theory, internal model principle

Lecturers Comments

In general we were happy with the course. This is an interdisciplinary course across Mathematics and Electrical Engineering. The course focuses on mathematical description of engineering problems. So, students with some engineering background are more interested in the course.

We think the course was a success for a cohort of students who have interests in both Mathematics and Electrical Engineering. The AMSI Summer School provided a valuable opportunity to gather together these students at an advanced level.

Associate Professor
Regina Burachik,
University of South Australia



To optimise is to search for a best option given the circumstances. The need for doing this is found everywhere from the natural and social sciences to engineering, business and economics. Optimising requires a model, a mathematical theory for solving the model, and a computer code to implement the theory. This course focused on the mathematical aspects of optimisation. The first part of the course gave basic tools of convex analysis, convex functions and separation theorems. We established optimality conditions for several kinds of optimisation problems, including convex (non-differentiable) and differentiable ones. In the second part of the course, we analysed convergence properties of classical optimisation methods, such as steepest descent, Newton, and their variants, for unconstrained problems. Finally, we studied penalty, barrier, and exact penalty methods for constrained problems.

Lecturers Comments

The students seemed to grasp the lecture content well and were especially receptive and enjoying of the mathematical proofs. The assignment and the quizzes were done well.

The lecture notes were well received by the students and the weekly reviews kept the students tuned with the progress in the topics. The reviews were directly linked to the quizzes, and this, I believe, helped the students to do well in the quizzes. Students commented positively on the material being challenging, interesting and new.

Course content

The course, week by week (taking into account one lecture of 90 min per week is a tutorial), was as follows:

- Week 1: Introduction to Optimisation problems: classification and examples. Elements of convex analysis: convex sets and convex functions, differentiability properties of convex functions, one-sided directional derivatives, epigraphs and level sets.
- Week 2: Separation results for convex sets, topological properties of convex sets, subgradients of convex functions. Existence of solutions of optimisation problems: boundedness and coerciveness. First and second order optimality conditions: unconstrained case. Constrained case: equality and inequality constraints for differentiable problems.
- Week 3: Sensitivity analysis for unconstrained optimisation. Optimality conditions for convex (non-differentiable) problems. Maximum of a convex function.
- Week 4: Methods for Unconstrained Optimisation: Newton method and its variants, and their convergence analysis. Cauchy and Armijo variants of steepest descent and convergence analysis of descent type methods. Methods for Constrained Optimisation: Penalty Methods, Exact penalty methods and Lagrange multipliers, Barrier methods.

"I thought that the assignments were of a good level. It was very intellectually stimulating and I feel like it was very relevant to my honours topic."

Summer School 2015 Participant

Women in Mathematics Special Interest Group Meeting

Organised by Dr Judy-Anne Osborn, Mumtaz Hussain and Naghmana Tehseen of the University of Newcastle, this event drew together an important group within the Australian community of mathematicians, providing support and information as well as a vital networking and mentoring opportunity. Jacqui Rammage from the University of Wollongong spoke on "How to say no by saying yes" and Regina Burachik of Universityof South Australia spoke about the need to follow your interests and passion even in the face of difficult practical challenges.

CV Workshop

Janice Jackson of the University of Newcastle's Careers Service gave an excellent description of the job application process, including useful tips on the building of a professional resume, interview techniques and career planning.

Lunchtime Lectures

On Mondays and Thursday, lunchtime lectures were organised to introduce summer school students to the many aspects of the mathematical research done by University of Newcastle academics and their collaborators

Professor Jon Borwein, The University of Newcastle

Computer Discovery and Visual Theorems in Mathematics

The increasing speed and storage capabilities of modern computer systems have allowed for an expansion of visual computing in mathematical research. In this talk, Jon showed how significant numerical-symbolic computation has imposed itself on fields as diverse as transcendental number theory Normality of real numbers), dynamic geometry (iterative reflection methods), probability (behaviour of short random walks) and matrix completion (protein conformation).

Professor George Willis, The University of Newcastle

Analysis, Symmetry and Locally Compact Groups

George highlighted links between topics studied in undergraduate mathematics on one hand -- continuity, differentiation, integration -- and frontiers of current research on the other -- totally disconnected locally compact groups (TDLCGs). Recent breakthroughs in the theory of TDLCGs were described as well as prospects for future developments.

Professor Rick Middleton, The University of Newcastle

Stability Analysis of a Class of 2D Systems

Rick described current research involving control of a class of systems evolving over two independent variables. Sufficient conditions for stability in terms of the divergence of a vector Lyapunov functions were described.

Associate Professor Eric Beh, The University of Newcastle

An Introduction to Correspondence Analysis: Eigen Decomposition, Singular Value Decomposition and Graphical Displays

Statisticians are often exploring data that lives in a multidimensional space and endeavouring to visualise it in as few dimensions as possible. Eric outlined the use the visualisation technique of correspondence analysis and links to eigen- and singular value decomposition.

Associate Professor Regina Burachik, University of South Australia

Conjugate Duality for Optimisation

Regina summarised the main ingredients and results of classical conjugate duality for optimisation problems, as given by Rockafellar in 1973.

The summer school featured a number of social events designed to bring students and lecturers together to break the ice and to give overtaxed brains a chance to relax.

Morning teas

Each day of class, a morning tea was held near the classrooms, offering a chance for students to quiz their lecturers over the latest theorem or complain about the heat!

Barbeques

Three barbeques were held near the student accommodation with a view to allowing students to meet students from other institutions and mingle with their lecturers in a laidback environment. Students hatched plans for the upcoming weekends, and cooled off in the swimming pool.

Quiz night

Local University of Newcastle students organised a Mathematics Quiz Night at an on-campus bar where teams competed for vouchers and bragging rights.

Movie Night

Newcastle's famous Regal Cinema (which is adjacent to the University campus) was the venue for the Australian premiere of the mathematical psycho-thriller "Travelling Salesman". The movie was preceded by a fascinating talk by UoN's Thomas Kalinowski on the unsolved Millenium Problem known as ``P Vs NP'' which outlined the premise of the movie. The movie was not as well-reviewed by the students as the choc-tops, which were outstanding!

Beach party

Summer school students and lecturers descended on Merewether Surf Lifesaving Club for lunch and drinks overlooking the ocean. We were lucky that Merewether has the largest ocean baths in the southern hemisphere as our plans to swim in the ocean were thwarted by the appearance of a 5-metre shark just offshore! Nevertheless, a competitive game of beach cricket broke out, as did good times.

Bushwalk

Summer School lecturer Murray Elder took the students on a morning bushwalk from Charlestown to Merewether through Glenrock Lagoon. There were tentative and nervous attempts to get wet as large sharks were spotted in the area on the morning of the walk. Tired walkers staggered back to the university late that night.

Summer School Dinner

The Summer School Dinner was held on the penultimate night of the Summer School at Noah's On The Beach Restaurant overlooking Newcastle Beach. Despite the inclement weather, dinner was a great success. Students and lecturers celebrated the end of the school and talked about future plans.

The after-dinner speaker was Professor Geoff Prince (Director of AMSI) who spoke about the need to improve the participation rates of women in the mathematical sciences and strategies to achieve that aim.

Careers Afternoon

The Careers Session is a popular feature of the AMSI Summer School; students have the opportunity to hear about career opportunities from employers specifically seeking mathematics and statistics graduates and network with employers over drinks.

This year the careers afternoon was attended by:

AMSI
AUSTRALIAN MATHEMATICAL SCIENCES INSTITUTE

optiver

Australian Government
Bureau of Meteorology

pwc

Australian Government
Department of Defence

THE UNIVERSITY OF NEWCASTLE
AUSTRALIA

CommonwealthBank

AMSIIntern

HVCCC
HUNTER VALLEY
COAL CHAIN
COORDINATOR

The event begins with employer and early career researcher presentations, which talk students through their personal career pathways and pathways within their organisations. The presentations open the door for lively discussion in the networking sessions, by highlighting opportunities that students are often unaware of.

All presentations can be accessed at:
http://ss15.amsi.org.au/careers-afternoon/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THE HITCHHIKERS GUIDE TO GEOMETRY

Dr Norm Do – **Monash University**

Friday 16 January 2015

Dr Norman Do of Monash University delivered the AMSI Summer School Public Lecture, titled ``The Hitchhiker's Guide to Geometry" in the Harold Lobb Concert Hall of the Newcastle Conservatorium of Music. Norman explored the interplay between geometry, algebra and theoretical physics in a talk that delighted the large audience. After the talk and a lively Q&A session, refreshments were served in the foyer with many members of the public mingling with Norman, Summer School lecturers, and other mathematicians.

Lecture Synopsis

People who study geometry like to ask the question: "What is the shape of that?" In this case, the word "that" can refer to a variety of things from triangles and circles, to knots and surfaces, to the universe we inhabit and beyond. In this talk, we will examine some of my favourite gems from the world of geometry and see the interplay between geometry, algebra, and theoretical physics. And the only prerequisite you will need is your imagination!

Dr Norman Do is, first and foremost, a self-confessed maths geek! As a high school student, he represented Australia at the International Mathematical Olympiad. He completed a PhD at The University of Melbourne, before working at McGill University in Canada. He is currently a Lecturer and a DECRA Research Fellow in the School of Mathematical Sciences at Monash University. His research lies at the interface of geometry and mathematical physics, although he is excited by almost any flavour of mathematics. Norman is heavily involved in enrichment for school students, regularly lecturing at the National Mathematics Summer School and currently chairing the Australian Mathematical Olympiad Senior Problems Committee.

HOLIDAY ROAD TRIPS ➡ ➡ ➡

made easier with maths and stats

NEWCASTLE, 27 DECEMBER 2014: Thousands of Australians will be hitting the roads this summer; cars packed with eskies, tents and boogie boards.

But who makes sure the roads are safe, the traffic lights change efficiently and any road works cause as little delay as possible?

One hundred and seven Australian students have opted to hit the books over the road this summer and attend the Australian Mathematical Sciences Institute's (AMSI) Summer School at the University of Newcastle from January 5 – 29.

Among other specialist subjects these students will be learning about current methods used in traffic flow management. Whether in the inner suburbs of your capital city or the great open roads of the Australian countryside, mathematics, statistics and computational techniques are essential for making our roads safer, our journeys more efficient and our holidays relaxing.

Professor Jan de Gier is the deputy director of the ARC Centre of Excellence for Mathematical and Statistical Frontiers (ACEMS) and will be teaching at AMSI's Summer School together with Dr Tim Garoni from Monash University.

"VicRoads is a frontrunner in realising that mathematics and statistics are essential to improve traffic networks," Jan says. "Theory and ideas borrowed from mathematical physics and statistical mechanics being taught at this Summer School are extremely adaptable to traffic modelling."

In fact, through a long running collaboration between VicRoads, Monash University, the University of Melbourne and the newly formed ACEMS, efficient simulators are being developed — such as CEASAR (ceasar.acems.org.au) — to mitigate bumps in your road.

"The beauty of the AMSI Summer School is that we can efficiently deliver state of the art mathematics and statistics, like this work on traffic management from Victoria, to a large number of future specialists in every state," says Professor Geoff Prince, AMSI Director.

He continues: "Over the last 12 years most Australian honours and PhD graduates in the mathematical sciences have benefited from our national research training programs, meeting a growing demand for quantitative skills in the economy. These programs have expanded over the last three years due in part to Department of Education and Trianing funding."

"I enjoyed having the opportunity to meet new people from around the country, and the ability to share interests in areas of mathematics. The courses have allowed me to broaden my knowledge to disciplines which I had little to no contact with previously"

Alex Mundey, **University of Wollongong**

Participation Statistics

08

A total of 107 students enrolled in the 2015 AMSI Summer School, of these 60 students took courses for credit.

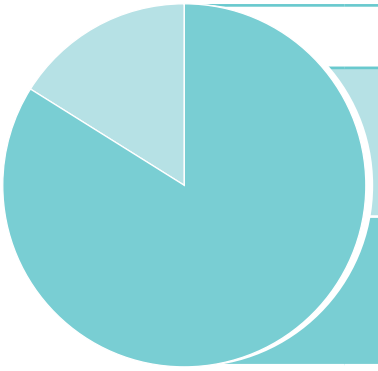
Students were encouraged to enrol in two courses, taking one for credit and auditing a second. They were expected to finalise their choice in week 2. A number of students changed their initial enrolment after they sat in on an extra course in week one.

Four students took two courses for credit, but this was generally experienced as too much work.

Enrolments

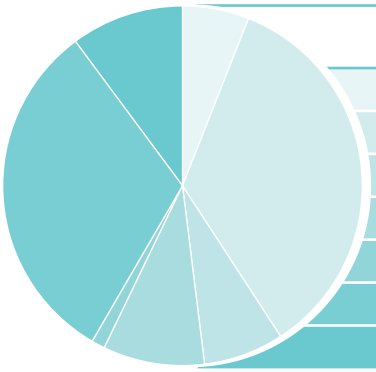
Australian Bureau of Statistics	3
Curtin University of Technology	3
Defence Science & Technology Organisation	1
Flinders University	5
La Trobe University	2
Monash University	10
Queensland University of Technology	1
RMIT University	1
Swinburne University of Technology	1
The Australian National University	7
The University of Adelaide	2
The University of Melbourne	13
The University of New South Wales	2
The University of Newcastle	18
The University of Queensland	6
The University of Sydney	4
The University of Western Australia	7
Universidade de Sao Paulo	1
University of South Australia	2
University of Tasmania	2
University of Technology Sydney	5
University of Western Sydney	1
University of Wollongong	9
Other	1
Total	**107**

Breakdown by Gender



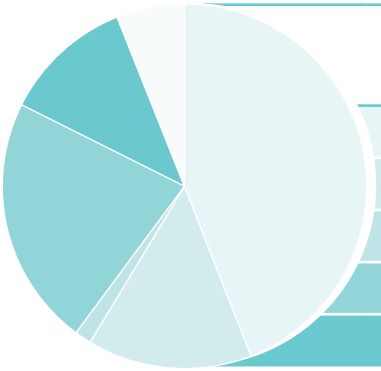
18%	Female
82%	Male

Breakdown by State



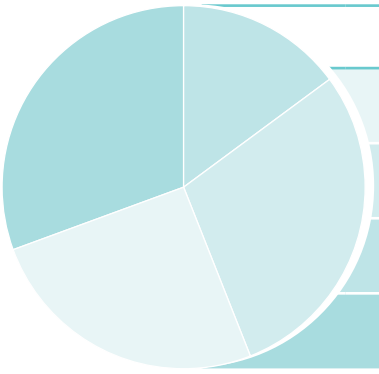
6%	ACT
35%	NSW
7%	QLD
9%	SA
1%	TAS
32%	VIC
10%	WA

Breakdown by Academic Status -

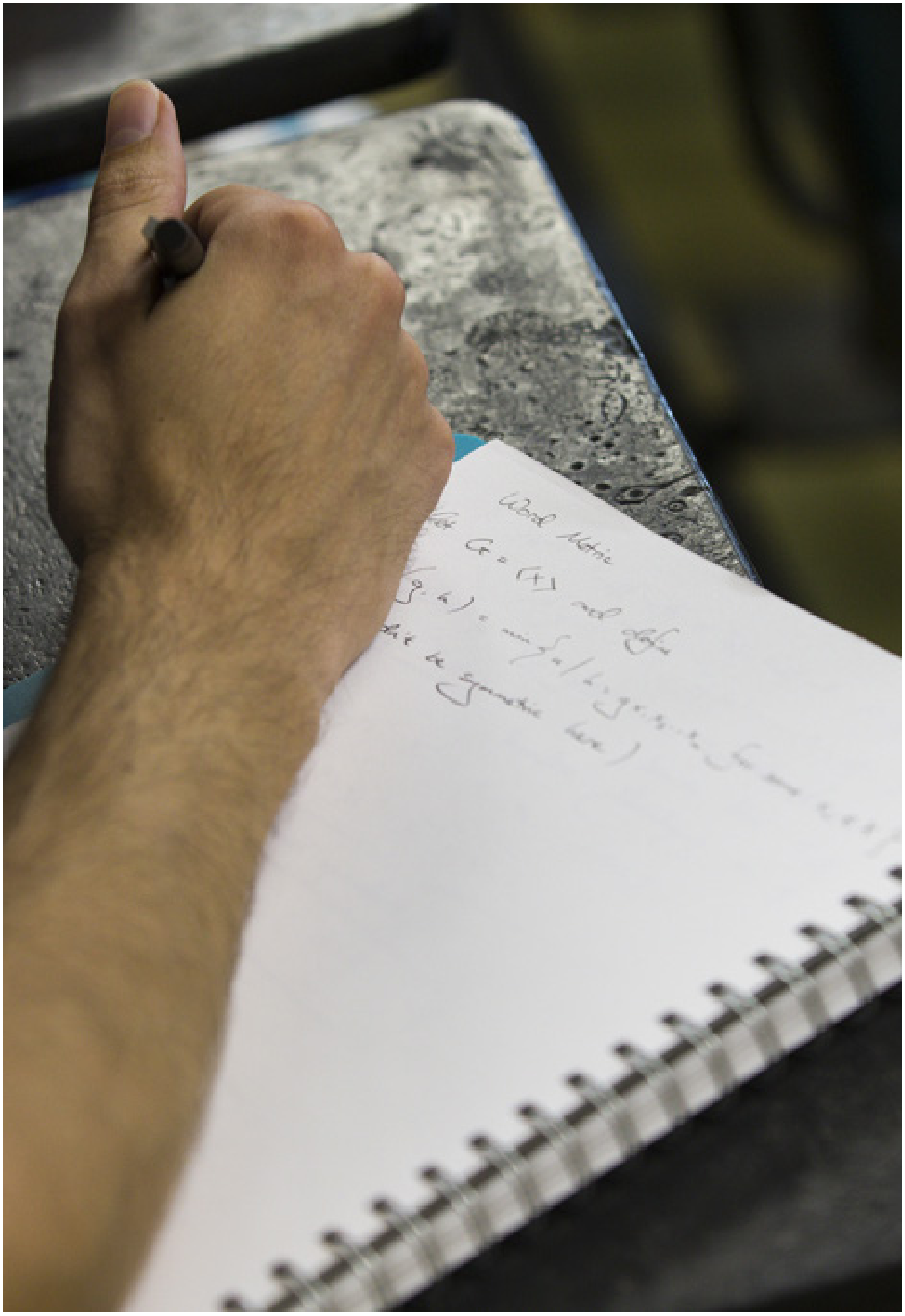


46%	Honours
16%	Undergraduate
2%	Postdoctoral
23%	PhD
13%	Masters

Breakdown by SES



25%	High
29%	Medium
15%	Low
31%	Unknown



What did you enjoy most about the experience?

"I made a lot of new friends from all across Australia, and the condensed four week unit was a great way to study, allowing me to more completely immerse myself in the content."
Ryland Newstead, **Monash University**

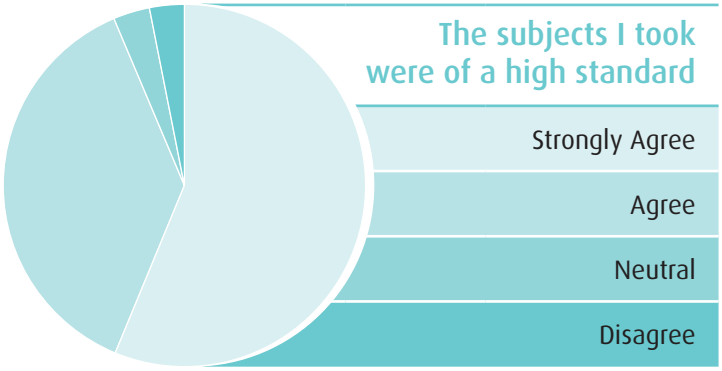
"The Summer School was an excellent way to get a broad introduction into various topics in a very short amount of time. It has saved me a lot of time (probably months!) in learning the same material independently."
Joel Ferguson, **The University of Newcastle**

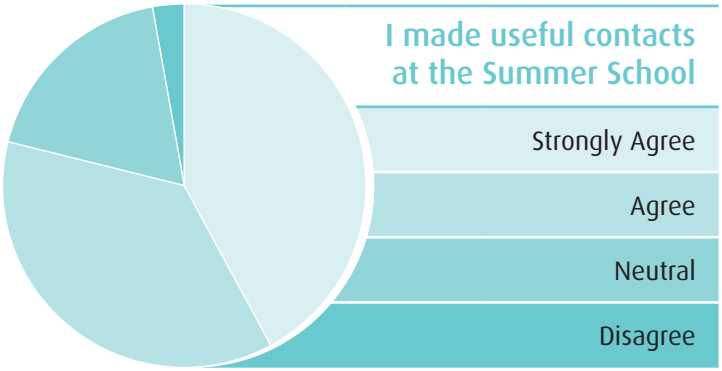
"The lecturer gave an excellent course which allowed the participants to gain a decent portion of his deep knowledge of the topic."
Heath Winning, **The University of Newcastle**

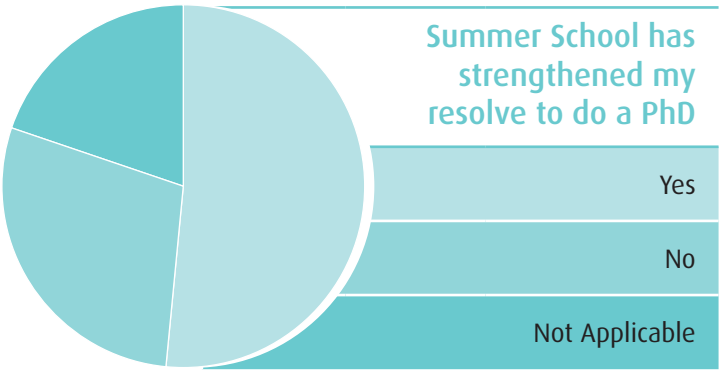
"The opportunity to meet academics and fellow students, both as a means of making contacts and learning about careers and research opportunities in mathematics."
Dominic Tate, **The University of Sydney**

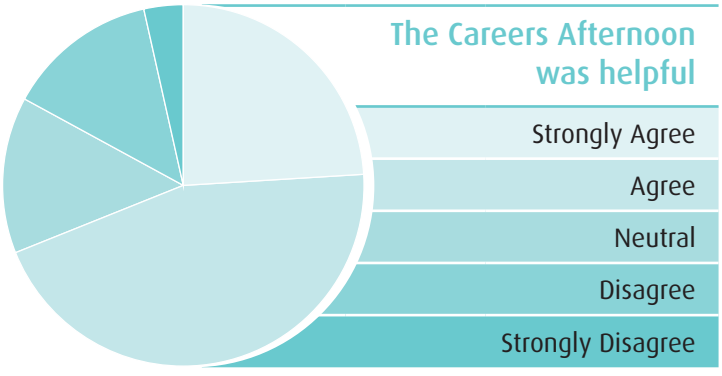
"The fact that the AMSI Summer School offers some very niche subjects that most universities can't provide, taught by the Australia's best mathematicians and statisticians. I also like how the teachers have all the time in the world for us to consult with them."
Mahrita Harahap, **University of Technology, Sydney**

"The intellectual content is of a high standard. The networking opportunities and social opportunities are valuable and unique. It is one of the few programs that elevates undergraduate mathematics in Australia to an international standard."
Daniel Ogburn, **The University of Western Australia**









Australia is a sporting nation and Norah Finn is a sports fanatic. When she realised sports and the mathematical sciences could mix, Norah jumped on board, and now considers the decision par for the course.

Norah discovered that her love for maths was as strong as her love for sports in Year 12. "I had a fantastic teacher in Year 12 who was extremely passionate about maths," Norah explains. "She motivated me to work hard and I realised how much I enjoyed the challenge of mathematics."

Norah attended AMSI's 2015 Summer School at the University of Newcastle. She says a residential school like this is a fantastic opportunity to be immersed in mathematics and statistics. "Staying at a college where all the students are studying the same field allowed us to bond like a sports team. We made good friends, learnt to collaborate and were able to teach and learn from each other," Norah says.

Summer 2014/15 was pretty hectic for Norah; not only did she attend Summer School but she was also awarded a Vacation Research Scholarship. Over six weeks Norah worked with our wheelchair rugby team and members of the Australian Paralympic Committee to investigate workload training. The purpose of her research was to determine how players perform in competition in comparison to when they train. Norah will continue with this project at RMIT for the next 12 months; it will be the research element of her honours degree.

"I didn't come to any major conclusions in my report," Norah says, "I have, however, set myself up very well for my honours year by getting a majority of the groundwork and coding done. I also have a well-defined set of goals."

Norah admires the real life application of statistics: it is used in every facet of life; is important to society and to how we progress forward; it is a mathematical way of describing what occurs in life; and it is a predictive tool to maximise our quality of life.

> "By supporting students to study and research in new and interesting fields, and by including outreach events, AMSI promotes the exciting things that the mathematical sciences can be used for."

She confesses that while her curiosities lie in sports statistics, on a day-to-day basis, statistics is crucial. "From medical research to government planning, statistics is used and can really change lives," Norah says passionately.

"Stats can help answer questions about where to build a new school or hospital or what the pros and cons are of building a train line as opposed to a road. More specifically," she says, "stats can assess the performance of new drugs, model the spread of viruses and help uncover ways to contain outbreaks. It is used in many aspects of finance. Or you can use it to see exactly how your sporting team is performing."

Even though Norah had no break between finishing her undergraduate degree and officially starting honours she said the ordeal was very fulfilling.

"Doing both Summer School and Vacation Research Scholarship, at the same time, taught me how to handle high intensity projects while still working to my full potential," Norah says confidently.

It isn't just the programs that Norah believes are of value; she reckons AMSI's work is on the money too. "The Institute encourages and promotes the study of mathematics in society, which is important in a society where the importance of studying mathematics receives not even a fraction of the air-time given to the importance of studying subjects such as English, law and medicine," Norah states.

Norah sums up her summer of maths and stats: "I would definitely recommend both events; they offer great opportunities. Summer School allows you to study with a new group of students, with fantastic lecturers from across Australia, studying subjects that may not be available at your home institution. And the Vacation Research Scholarship allows you to experience what research is like and gives you a feel for honours. It also gives you the experience to present your research and to hear the work of other students with similar interests – an opportunity not readily available."

> "From medical research to government planning, statistics is used and can really change lives,"

And she concludes with her thoughts about AMSI: "By supporting students to study and research in new and interesting fields, and by including outreach events, AMSI promotes the exciting things that the mathematical sciences can be used for."

Keep your eyes and ears out for Norah Finn, her research and enthusiasm for sports will see her shepherding her way to a sporting club, as statistician very soon.

Committees

The 2015 AMSI Summer School wishes to acknowledge the generous donation of time and scientific advice of the following committees, without their contribution this event would not be a success.

Local Organising Committee

Dr Jeffrey Hogan
The University of Newcastle - Director

Dr Michael Coons
The University of Newcastle

Dr Murray Elder
The University of Newcastle

SUMMER SCHOOL STANDING COMMITTEE/ PROGRAM COMMITTEE

Professor Jan de Gier
The University of Melbourne – 2013 Summer School Director

Simi Henderson
Australian Mathematical Sciences Institute

Dr Jeffrey Hogan
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University of Adelaide

Professor Geoff Prince
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Mathematical Statistical Mechanics
Jan De Gier & Nathan Clisby, The University of Melbourne & Tim Garoni, Monash University

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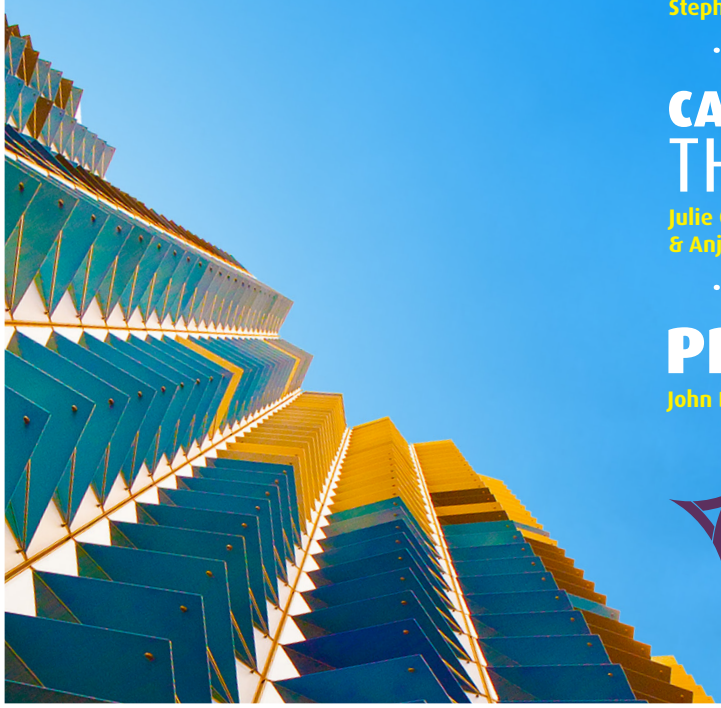

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