2013/14

AMSI Summer School

The Australian National University
6-31 January 2014

AMSI
AUSTRALIAN MATHEMATICAL SCIENCES INSTITUTE

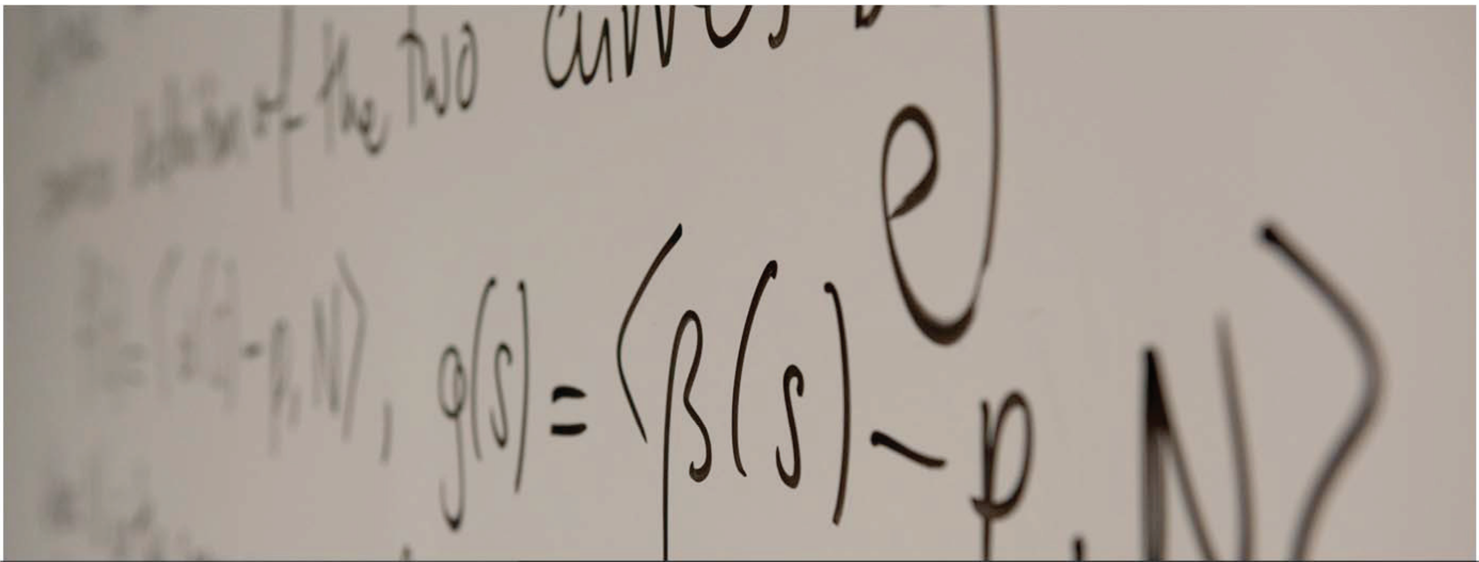
Australian National University

Australian Government
Department of Education

AustMS
Australian Mathematical Society

ANZIAM

Mathematics of Planet Earth 2013 Australia



INTRODUCTION

Strengthening education in the mathematical sciences

The 2014 AMSI Summer School is one of the big annual events in the Australian Mathematics calendar.

This year, 155 students from across Australia attended the AMSI Summer School. The four-week school provided students with the opportunity to tackle, in an intensive period, one or two subjects chosen from the eight honours-level subjects in pure and applied mathematics and statistics. The academic work was complemented by enrichment lectures, social events, a careers afternoon, and other special events. All these events were well attended. I want to acknowledge the contribution of the program committee and my colleagues on the organising committee and of the professional staff at the Australian National University, especially Brittany Shoard, from the Centre for Mathematics and its Applications, for all their efforts in ensuring a very successful school.

Associate Professor Jan de Gier, the Director of the 2013 AMSI Summer School, helped me by answering many questions throughout the organising process.

Much of the organisation was handled by Professor Geoff Prince, Simi Henderson, and other AMSI staff.

Many people contributed to the social events, enrichment lectures, and other special events during the summer school. I want to particularly mention a group of PhD students from the mathematics department at the Australian National University who put on the much-appreciated social activities.

The lecturers did an outstanding job with enthusiasm and dedication. The fast pace of the Summer School was as demanding for them as it was for the students. It has been a pleasure and a privilege to work with all these people, and the enthusiasm and appreciation shown by the students made it all worthwhile.

Assoc. Prof. Stephen Roberts
Director, 2014 AMSI Summer School

COMMITTEES

The 2014 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.

Program Committee

Associate Professor Jan de Gier, The University of Melbourne
Ms Simi Henderson, AMSI
Associate Professor Inge Koch, The University of Adelaide
Professor Geoff Prince, AMSI
Associate Professor Stephen Roberts, Australian National University
Dr Stephan Tillman, The University of Sydney

Organising Committee

Associate Professor Stephen Roberts (Director), Australian National University
Dr James Borger, Australian National University
Ms Donelle Claudianos, Australian National University
Dr Lilia Ferrario, Australian National University
Professor Markus Hegland, Australian National University
Ms Simi Henderson, AMSI
Professor Geoff Prince, AMSI
Ms Brittany Shoard, Australian National University

SUBJECTS

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

BIOINFORMATICS

Dr Conrad Burden, Australian National University

AN INTRODUCTION TO CONFORMAL FIELD THEORY AND STRING THEORY FOR MATHEMATICIANS

Professor Peter Bouwknegt, Australian National University

Dr David Ridout, Australian National University

DIFFERENTIAL GEOMETRY

Dr Ben Andrews, Australian National University

Dr Julie Clutterbuck, Australian National University

THE FINITE ELEMENT METHOD

Dr Bishnu Lamichhane, University of Newcastle

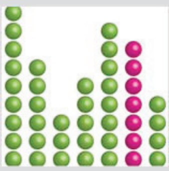
HIGH DIMENSIONAL DATA: MODELS, MODEL SELECTION, VARIABLE RANKING AND SPARSITY

Associate Professor Inge Koch, University of Adelaide

Dr Samuel Mueller , University of Sydney

INTRODUCTION TO HYDRODYNAMIC STABILITY

Associate Professor Sergey Suslov, Swinburne University of Technology



VECTOR BUNDLES AND K THEORY

Dr Vigleik Angelveit, Australian National University

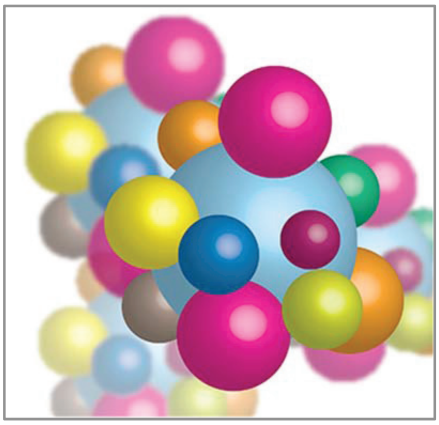
STATISTICAL INFERENCE

Professor Alan Welsh, Australian National University

Associate Professor Robert Clark, University of Wollongong

HIGH DIMENSIONAL DATA: MODELS, MODEL SELECTION, VARIABLE RANKING AND SPARSITY

Associate Professor Inge Koch, University of Adelaide
Dr Samuel Mueller , University of Sydney



The analysis of high-dimensional data poses theoretical and computational challenges that require knowledge of classical multivariate methods, including regression and contemporary approaches from statistical learning.

The first part of the course focused on model selection techniques for linear and generalised linear regression in two scenarios: when an extensive search of the model space is possible as well as when the dimension is large. Students learned the various competing model selection criteria, such as AIC, BIC and Mallows Cp and their use in stepwise algorithms or regularisation techniques to identify good models. Recent research on graphical tools for model choice was incorporated and it was shown how robust model selection criteria can be constructed as well as how to best tune regularisation procedures, such as Ridge or Lasso regression.

The second part covered a basic background in principal component analysis, canonical correlation analysis and discriminant analysis. Then moved on to high dimensional data and high-dimension low sample size data for which the classical theory needs to be modified. We learnt about principal component analysis in linear regression and discriminant analysis for such data, variable ranking and variable selection and subsequent dimension reduction. Our final topic covered sparse principal component analysis which mimics ideas from linear regression and, suitably modified, can work well in finding a small(er) number of principal components.

The practical implementation the methods was an essential component of the course, R was used in the first part and Matlab in the second.

Lecturers' Comments

It was enjoyable teaching at the summer school. Although the teaching and learning was very intense, the students were keen to learn and expressed their interest in the course.

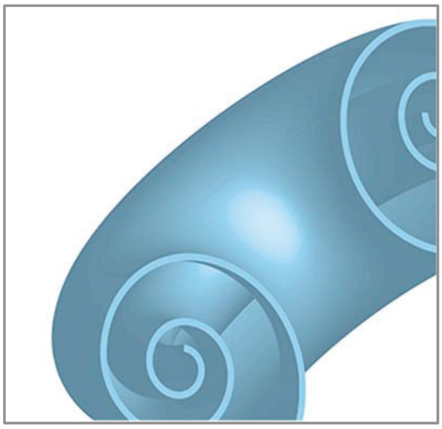
Contact hours
28 hours spread over the four weeks, with consultation upon request.

Assessment
Two assignments worth 20% each and a three-hour exam worth 60%.

Credit
Four students took the subject for credit.

THE FINITE ELEMENT METHOD

Dr Bishnu Lamichhane, University of Newcastle



The finite element method is one of the most powerful techniques in approximating the solution of partial differential equations arising in the mathematical modelling of many physical and engineering processes.

The finite element method is based on a firm mathematical foundation, where mathematical tools from functional analysis, approximation theory and variational calculus are applied to analyse the whole approximation process.

The course aimed to introduced the theory and computation of finite element techniques for elliptic partial differential equations.

The course content was divided into three parts as follows:

- Sobolev spaces, weak formulations of elliptic partial differential equations, existence and uniqueness of the weak problem
- Galerkin method, a priori error estimate, higher order elements, finite elements on simplicial, quadrilateral and hexahedral grids, time dependent problems, mixed finite elements
- Computer implementation of finite element methods

Lecturer's comments
I was overwhelmed by the friendly and supportive working environment during the Summer School and the great support from Associate Professor Stephen Roberts and the Mathematical Sciences Institute staff at Australian National University.

I greatly enjoyed the whole summer school. The social interactions and other events were very well organised. I think the AMSI summer school is one of the most important AMSI activities.

"I greatly enjoyed the whole Summer School."

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- Dr Bishnu Lamichhane

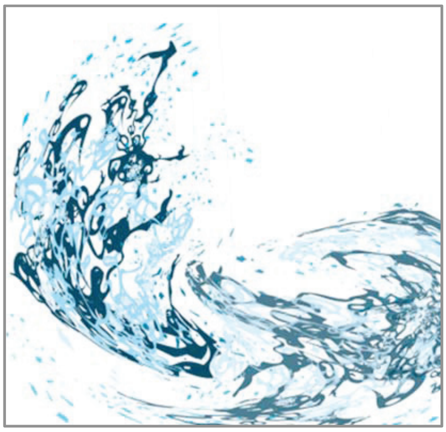
Contact hours
28 hours spread over the four weeks, with consultation upon request.

Assessment
Two assignments worth 25%, one take home exam worth 25% and a three hour exam worth 25%.

Credit
Eight students took the subject for credit.

INTRODUCTION TO HYDRODYNAMIC STABILITY

A/Prof Sergey Suslov, Swinburne University



Various fluid flows surround us in everyday life. It is amazing how different they can be even if the conditions in which they occur seem to be very similar.

You fill a pot with water and put it on a cook-top to boil, the water stays still for a while, but all of a sudden it starts moving, some rising, some sinking.

You are hosing the garden and the water jet is almost perfectly round near the nozzle. Why does it break a few centimetres away from it?

You are bored painting a fence: so tedious, why doesn't paint flow smoothly all along a paling if poured from the top?

All these examples are illustrations of phenomena known as hydrodynamic instabilities. Modern mathematics can predict and explain them using the ideas of dynamical system and bifurcation theories.

Topics covered:

- Introduction to dynamical systems: analysis of fixed points and the concept of their stability. Nonlinearity of equations and non-uniqueness of solutions, bifurcations.
- Equations of fluid mechanics, their properties, physical meaning and simple solutions.
- Infinitesimal perturbations in fluid mechanics, their normal mode decomposition and stability via a generalised eigenvalue problem. Bifurcations of simple flows and their physical interpretation.
- Low-order reduction of fluid PDEs to ODEs and the use of ideas of dynamical system theory for weakly nonlinear analysis of finite amplitude flow perturbations: solvability condition and amplitude equations; classification of fluid flow bifurcations and their signature in the phase plane.

Lecturer's Comments

I am pleased with very positive student comments on the subject and my teaching, I found it very rewarding to work with such a capable and bright cohort of students.

The AMSI Summer School is one of the most important and rewarding AMSI activities for both students and lecturers involved. The fact that this year's enrolment exceeded all predictions is the strongest is confirmation of this.

The school was very well organised from both academic and social points of view.

AGENCY GUEST LECTURER

Dr Malcolm Jones from the Defence Science and Technology Organisation (DSTO) Aerospace Division illustrated how the concepts studied in class work in application.

Contact hours

28 hours spread over the four weeks, with consultation upon request.

Assessment

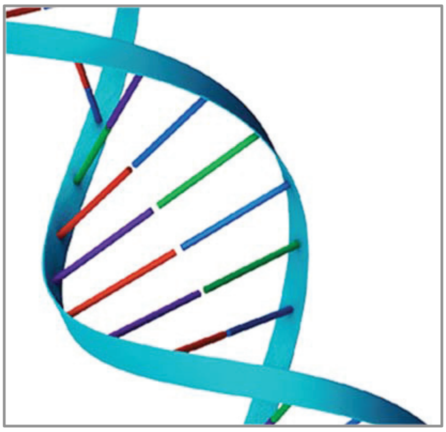
Two assignments worth 20% each, plus a 3-hour exam worth 60%.

Credit

Nine students took the course for credit.

BIOINFORMATICS

Dr Conrad Burden, Australian National University



Bioinformatics is a rapidly growing interdisciplinary field concerned with the use of computational methods to solve biological problems related to DNA and amino acid sequence information. Typical problems addressed by bioinformaticians are identifying functionally different parts of a genome, searching DNA or protein databases to find sequences which are functionally similar to a given query sequence, or inferring the relatedness of different species by measuring the similarity of their genomes.

The course consisted of four parts:

- A crash course in probability theory
- Analysis of a single DNA sequence including shotgun sequencing and word counts in random sequences
- Analysis of multiple sequences including alignments, assessing the significance of alignment scores and the mathematics behind the BLAST algorithm
- Analysis of data from modern high throughput sequencing including detection of differential gene expression from RNA-sequencing data.

The course covered the mathematical theory behind some of the algorithms commonly used by biologists and also gave examples of current research. No prior knowledge of biology was assumed and one lecture was devoted to explaining basic principles in biology.

Students also learnt some basic programming in R.

“I was impressed with the level of enthusiasm and commitment from the students”
- Dr Conrad Burden

Lecturer’s Comments
It was a pleasure to be able to give this course to a broader audience. Bioinformatics is a rapidly growing field, biology continues to become a more quantitative branch of science dealing with large datasets generated by modern high-throughput experimental techniques.

The large enrolment for this course is evidence that there is a need to provide students with training in the more mathematical aspects of bioinformatics.

I was impressed with the level of enthusiasm and commitment from the students. I received plenty of feedback and interaction during lectures, and even received an offer from a biologist in the class (which I accepted) to give a demonstration of the use of the BLAST algorithm for searching protein databases using an example from her own research.

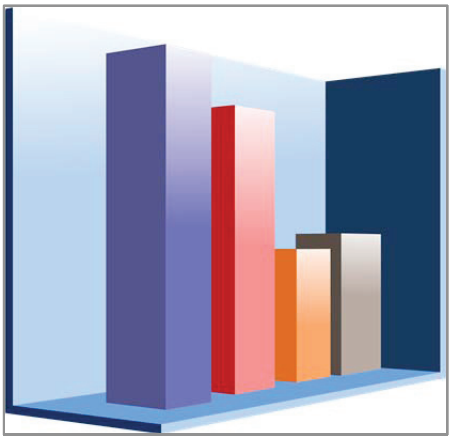
The organisation of the School was excellent. Everything ran smoothly and problems were ironed out quickly and efficiently.

Contact hours
28 hours spread over the four weeks, with consultation upon request.

Assessment
Two assignments worth 25% each, plus a 3-hour exam worth 50%.

Credit
22 students took the course for credit

STATISTICAL INFERENCE



Professor Alan Welsh, Australian National University
Associate Professor Robert Clark, University of Wollongong

Parametric statistical models are at the heart of statistics because they are a very effective starting point for extracting and conveying information obtained from empirical data. Likelihood methods provide a framework for initiating these processes, particularly in structured and complicated problems. A good understanding of likelihood theory and how to apply it is therefore extremely useful to statisticians. The course differs from standard introductory inference courses in that it focuses on understanding, using and applying likelihood methods when the assumed model is not exactly correct and the data are incomplete, rather than the basic concepts of inference (such as statistical tests and confidence intervals) or different approaches to inference.

The course covered:

- Introduction/revision of likelihood theory including point estimation, hypothesis testing and interval estimation.
- Robustness against distributional contamination, focusing mainly on the bounded influence approach. After discussing single-parameter problems, we will discuss location-scale and regression problems.
- Incomplete data problems, including controlled incomplete data problems such as arise in sampling from finite populations and uncontrolled incomplete data problems such as arise with missing data and other forms of nonresponse. The main tool for this part will be the expectation maximisation (EM) algorithm, both implemented directly and through the Missing Information Principle.

"Rigour was excellent; robustness challenging"

- 2014 Summer School Participant

Lecturers' Comments
The subject went well, with over 30 students learning some advanced inference material not taught elsewhere.

Students commented positively on the material being stretching, interesting and new.

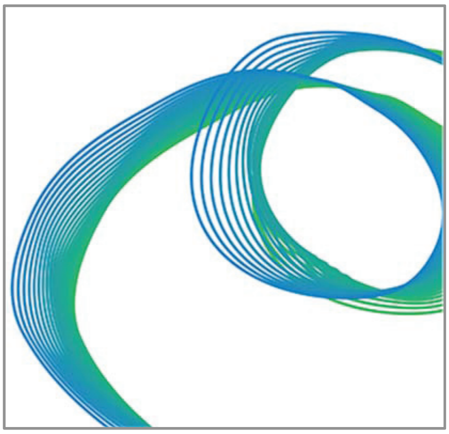
Contact Hours
28 hours spread over 4 weeks, with consultation upon request.

Assessment
Two assignments worth 20% each and a three-hour exam worth 60%.

Credit
Four students took the subject for credit.

AN INTRODUCTION TO CONFORMAL FIELD THEORY AND STRING THEORY FOR MATHEMATICIANS

Professor Peter Bouwknegt, Australian National University
Dr David Ridout, Australian National University



In these lectures we gave an introduction to the basics of both (2-dimensional) conformal field theory and string theory. In particular, we discussed in detail the simplest example of a conformal field theory (vertex operator algebra), the free boson, and illustrated how this theory arises in the quantisation of the free bosonic string in Minkowski spacetime. Several more general theories (e.g. fermions and superstrings) were also briefly introduced.

We started with some very basic Lie Algebra Theory (via examples) before introducing conformal transformations and the Virasoro algebra. Canonical quantisation of a classical free massless boson led us to study representations of an infinite-dimensional Lie algebra. The field-theoretic nature lets us "overlay" this representation theory with a new (and very powerful) algebraic structure called the operator product expansion.

The conformal field theory techniques developed in the first part of the course were used to discuss in detail the quantisation of (both open and closed) bosonic strings in flat spacetime, including the derivation of the critical dimension, choice of boundary conditions (D-branes), scattering amplitudes and dualities for strings compactified on tori. We briefly discussed the generalisation to superstrings.

Lecturers' Comments
It was a pleasure teaching the course as most of the students were very engaged and kept asking all sorts of questions, not just about the material covered in the lectures.

There is clearly a cohort of students that are interested in courses on the boundary of mathematics and physics, and we recommend such a course, not necessarily on exactly the same topic, being offered at each summer school.

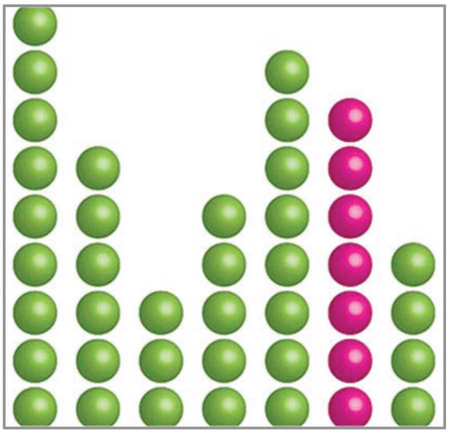
Contact Hours
28 hours spread over 4 weeks, with consultation upon request.

Assessment
Two assignments worth 20% each and a three-hour exam worth 60%.

Credit
Eight students took the subject for credit.

VECTOR BUNDLES AND K THEORY

Dr Vigleik Angelveit, Australian National University



The aim of the course was to use *K*-theory to prove the following theorem:

Theorem 1. *The vector space $\mathbb{R}^n$ can be given the structure of a real division algebra only for n = 1, 2, 4 and 8.*

Examples are given by the real numbers $\mathbb{R}$, the complex numbers $\mathbb{C}$, the quaternions $\mathbb{H}$ and the octonions $\mathbb{O}$. A closely related statement is that the sphere S^{n-1} can be given an H -space structure (a multiplication) for the same values of n, or that S^{n-1}has $n-1$ nowhere dependent vector fields. Any of these statements can be reduced to the existence of a map $f: S_{2n-1} \to S_n$ of Hopf Invariant One, and this is how the result is usually proved.

The original proof by Adams (around 1960) used secondary cohomology operations and is long and painful. But a few years later Adams and Atiyah gave an alternative proof using *K*-theory, and this proof is short enough to fit in a single lecture if the audience knows about *K*-theory.

In the first couple of lectures we discussed some background material on point-set topology and linear algebra, before we spent some time on vector bundles and how to construct them both using clutching functions and by pulling back the universal bundle over the appropriate classifying space.

Then we defined *K*-theory and used it to prove some standard results that are usually proved using ordinary homology in a first course in algebraic topology. Next we introducted the Adams operations acting on K-theory, before proving the main theorem. One can argue that we did not present a complete proof because we skipped a few details when discussing K-theory; the most important omission being that we did not prove Bott periodicity.

After proving the main theorem we still had a little bit time left, which we used to discuss Clifford algebras.

"I think the general framework of the summer school is good, and I am quite sure I would have enjoyed it as an undergraduate."

- Dr Vigleik Angelveit

Lecturer's Comments

My goal was to teach a course at approximately the same level as an introductory algebraic topology course, but with the content being orthogonal to that so that students could benefit from it with or without a background in algebraic topology. I think it was a success, and some of the students became excited about algebraic topology and were motivated to learn more.

Contact Hours
28 hours spread over 4 weeks, with consultation upon request.

Assessment
Two assignments worth 20% each and a three-hour exam worth 60%.

Credit
12 students took the subject for credit.

DIFFERENTIAL GEOMETRY

Dr Ben Andrews, Australian National University
Dr Julie Clutterbuck, Australian National University

The first week of the course concerned curves, beginning with the local theory (arc length, curvature and torsion, the tangent, normal and binormal and the Serret-Frenet equations) and went on to prove several global results (including the isoperimetric inequality, the four-vertex theorem and the theorem of turning tangents).

In the second week, we first introduced the concept of submanifold and the associated notions of tangent spaces, local parametrisations, embeddings, submersions and diffeomorphisms, and the first fundamental form. The point of view was more general here than the usual elementary course which restricts attention to surfaces in space, and the focus was on developing facility with the inverse and implicit function theorems.

From midway through the second week through to the end of the third week we developed the theory of hypersurfaces. This began with the unit normal and shape operator or second fundamental form, and continued in the local theory with the derivation of the fundamental Gauss and Codazzi equations, culminating with the result that these are the obstructions to embeddability for given first and second fundamental forms. In the course of proving this we also developed the submanifold connection and the concepts of tensors and covariant differentiation, including the definition of the curvature tensor in order to give a meaningful interpretation to the Gauss equations.

The third week was devoted to some global theorems for hypersurfaces, including rigidity results for spheres and ovaloids, and theorems on constant mean curvature and constant Gauss curvature surfaces, as well as brief treatments of special classes of hypersurfaces including minimal surfaces and ruled surfaces.

In the final week we introduced the concepts of inner geometry and abstract manifolds, geodesics and the exponential map, and proved several important theorems, including: The classification of constant curvature spaces; the Hopf-Rinow theorem on completeness and geodesic completeness, the Bonnet-Myers and Hadamard theorems, and the Gauss-Bonnet theorem.

Lecturers' Comments
The course was successful, we were happy with the scope of the material covered, and were pleased with the enthusiasm and engagement of the students with the material.

Offering the AMSI course was a rewarding experience, and it is clear to us that it is a very valuable experience for the students also, not only for the material taught in the courses but also for the opportunity to interact with other interested students from around the country.

Contact Hours
28 hours spread over 4 weeks, with consultation upon request.

Assessment

One assignment worth 30%, one project worth 30% and one oral exam worth 40%.

Credit
11 students took the subject for credit.

PROGRAM HIGHLIGHTS

SUMMER SCHOOL DINNER

The Summer School dinner is held in the last week of the Summer School and is an opportunity for students and lecturers to celebrate the end of the school and cement new friendships.

The dinner speaker, Dr Ron Sandland, Chair of the AMSI Board and former CSIRO deputy chief executive, spoke about examples from his life and time at CSIRO, where mathematics and statistical thinking and methods has had a great influence.

He gave examples where CSIRO was able to save millions of dollars for companies such as BHP Billiton and other Australian companies.

DR RON SANDLAND
AMSI BOARD

LUNCHTIME LECTURES

Each week special lunchtime lectures gave students the opportunity to hear about exciting research taking place at the Australian National University.

Dr Tim Trudgian	**The Riemann hypothesis: 1 for 500 at stumps on day one** Working on problems connected to the Riemann hypothesis is a hard slog. In this talk Tim illustrated how far mathematicians have come, how far there is to go and what definitely doesn't work.
Dr Pierre Portal	**Fourier analysis without Fourier transform** In this talk, we look at some of the classic incarnations of Fourier's idea, before considering them from a modern point of view: as analysis techniques adapted to certain differential operators.
Dr Dennis The	**Symmetry and Geometric Structures** I'll give some more examples from a rich and interesting class of structures called parabolic geometries, and give some rough ideas on the interplay between differential geometry and representation theory inherent in this picture.
Dr Scott Morrison	**Knots and quantum computation** This talk tries to explain a crazy idea for building a quantum computer that works by braiding certain exotic particles around each other.

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: Optiver, Centre of Excellence for Climate System Science, Australian Bureau of Statistics, Australian Signals Directorate, CSIRO, Commonwealth Bank, Geoscience Australia, Defence Science and Technology Organisation, and the Australian National University.

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.

"I was impressed by the number and depth of the questions I was asked."

- Richard Wardle, Bureau of Meteorology

"Very useful. It showed me a few different careers that I had never linked to a maths degree"

2013 Summer School Student

SOCIAL EVENTS

A number of social events run though out the Summer School, students and lecturers come together to socialise and have a break from studying.

AMAZING RACE ICEBREAKER

On the first Saturday of the school, students built friendships and discovered some of Canberra's attractions by participating in the Summer School Amazing Race. In teams of two, students spent the day solving puzzles at Parliament House, implementing the Four Colour Theorem on a map of Canberra, discovering some of the quirky attractions in Garema Place, exploring the War Memorial's displays and appreciating Walter Burley Griffin's vision from the top of Mt Ainslie.

The first team to return won a Canberra entertainment book, the second team won a meal at Brodburger, and the third team took home souvenir Canberra travel mugs.

A great time was had by all, and the students got a little taste of what Canberra has to offer! Thanks to Chaitanya Shettigara for coordinating this event.

FRIDAY BBQS

Friday night BBQs where run throughout the Summer School creating a relaxed environment for students and the lecturers after a hard week of mathematics.

The BBQs gave the students the opportunity to build friendships, organise plans for the upcoming weekend and catch up with their lecturers outside of the classroom. It wasn't all talk though, with many evenings ending in a friendly game of cricket.

QUIZ NIGHT

What better way to unwind after weeks of advanced mathematics than with a trivia night? The Summer School trivia night covered all topics from second-order elliptic PDE textbooks to the aviation experience of David Boon, the participants had their minds thoroughly prodded and bent. Dymocks book vouchers and math kits (instant coffee, pens and notepads) where given to the top scoring teams.

Thanks to Australian National University PhD student and maths society president Alex Amenta for organising the Summer School Quiz night.

PARTICIPANTS

A total of 155 students enrolled in the 2014 AMSI Summer School, 69 of these students took courses for credit.

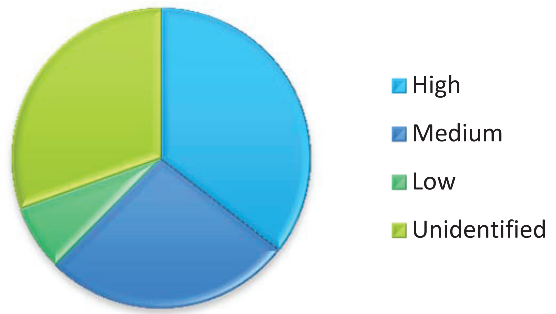
Students were encouraged to enrol in two courses, taking one for credit and auditing a second (on average students took 1.9 courses). They were expected to finalise their choice in week 2. A number of students changed their initial enrolment after they sat in on an extra course in week one.

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

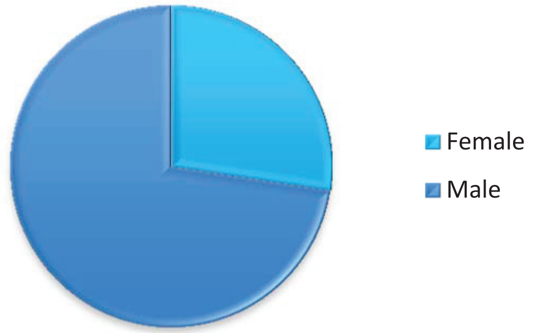
Enrolment numbers by university/organisation

University of Adelaide	12
Australian National University	42
Murdoch University	1
Curtin University	2
Flinders University	2
LaTrobe University	4
University of Melbourne	11
Monash University	5
Macquarie University	2
University of Newcastle	1
Queensland University of Technology	4
Royal Melbourne Institute of Technology	2
Department of Employment	1
University of Sydney	9
University of New England	2
University of New South Wales	5
University of Queensland	14
University of South Australia	3
University of Tasmania	1
University of Technology Sydney	3
University of Western Australia	8
University of Wollongong	7
The Australian Bureau of Statistics	1
Other	12
Total	**155**

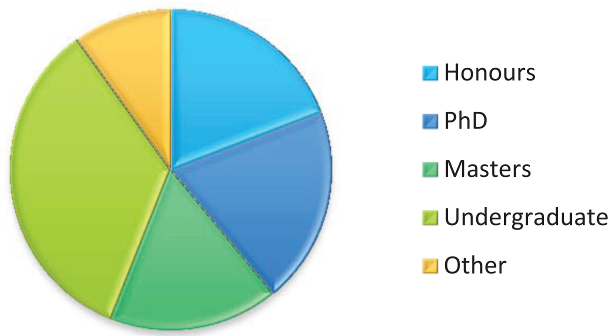
ENROLMENT BY SOCIOECONOMIC STATUS



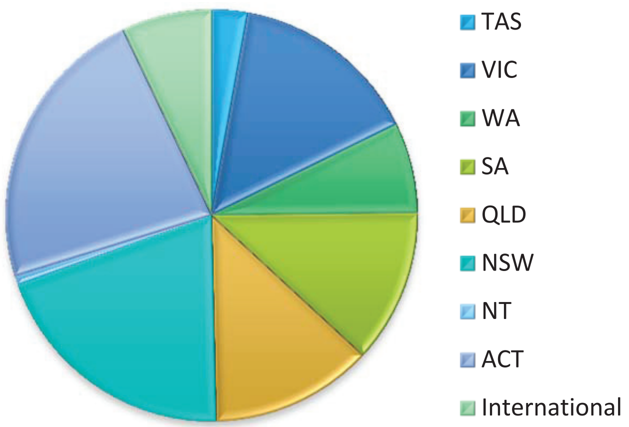
ENROLMENT BY GENDER



ENROLMENT BY TYPE



ENROLMENT BY STATE



FEEDBACK

" It (the careers afternoon) was good to have industry reps present. Definitely interesting to see the range of options available. I am Interested in entering the industry because of it."

- Matt Hayel

"A unique opportunity to connect with the present and future generations of mathematicians in Australia."

- Daniel Ogburn

" It was good studying subject matter not available at my home institution"

- Matthew Tuson

NAME THE THREE BEST THINGS ABOUT SUMMER SCHOOL

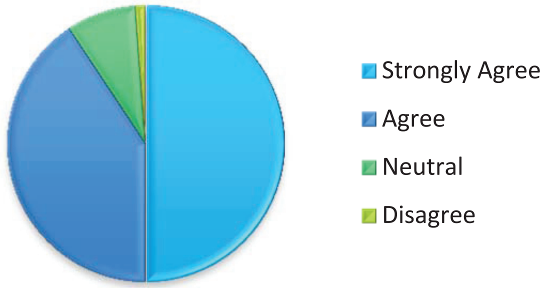
"AMSI Summer School was an incredible opportunity to become exposed to new mathematics and to develop new friendships with like-minded people. There's no other place where it is perfectly acceptable to discuss calculus over breakfast"

"A great experience for anyone who enjoys science"

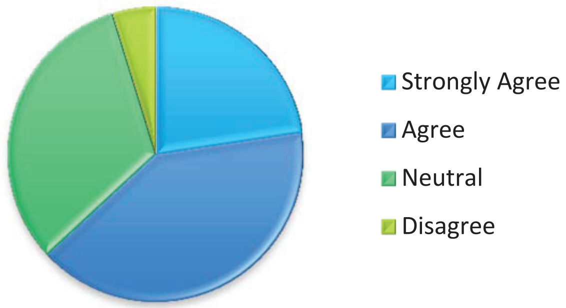
" It was great having the opportunity to study interesting topics with other students with similar interests, without all the usual distractions back home."

"It (AMSI Summer School) opened my mind about our job as mathematicians"

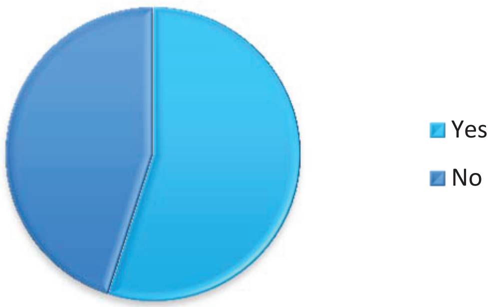
THE SUBJECTS I TOOK WERE OF A HIGH STANDARD



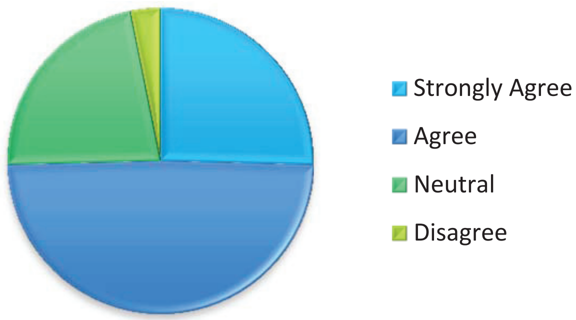
I MADE USEFUL CONTACTS AT THE SUMMER SCHOOL



SUMMER SCHOOL HAS STRENGTHENED MY RESOLVE TO DO A PHD



THE CAREERS AFTERNOON WAS HELPFUL



STUDENT PROFILE

Waiting game? Or Numbers game?

KATE ATWELL
THE UNIVERSITY OF ADELAIDE

We all know what it is like to be in a queue. Standing in line for our morning coffee; pressing six digits on our touchscreen before finally getting to speak to someone; queues can be plain and simple or utterly complex. What we probably aren't aware of while we're flicking through a magazine in the supermarket checkout-queue is that there is a whole branch of mathematics devoted to studying the intricate nature of waiting.

Kate Atwell has recently embarked on an honours project at the University of Adelaide that looks at queuing theory. Specifically, Kate's research is focused on queues with several options or steps – like calling the bank. She is looking at how we enter and exit queues and what steps we need to take on the way.

''When you call the bank, firstly an automated voice asks you to press a number related to your query, following this there may be several other responses you have to give before you finally get to speak to a member of the bank. My research looks at these added complications and how you move forward — one phase at a time — until you reach the end of the queue. In this case, the real person!' Kate said.

Kate has travelled to most capital cities in Australia, but she will always call Adelaide home. For Kate, Adelaide is just right – not too busy, not too quiet. The other thing that Kate finds just right is mathematics.

'Though always there, my interests in mathematics were spiked when I was taught by a particular teacher,' Kate said, 'This teacher, having previously completed a mathematics degree herself, had a passion for mathematics that was inspiring and motivating.'

Kate Attwell attended AMSI's 2014 Summer School to ease the pressure of her honours year. She didn't expect to be surrounded by so many people who share her pursuit of knowledge. Kate said that the second best thing about the summer was meeting other honours and PhD students from around the country studying mathematics. 'You just know these people are in the field for the love it, which isn't always the case in other faculties,' she said.

'The best thing about AMSI's Summer School — and other AMSI events — was that it gave me the opportunity to study a course that I would not have been able to at my own university. It also made me aware of a fascinating field of mathematical research that I would not have known about otherwise.'

So the next time you're in a queue have a think about Kate and the high-end mathematics she uses to calculate how you wait, and where your choices take you.

"I found it very rewarding to work with such a capable and bright cohort of students."

- Assoc. Prof. Sergey Suslov

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