NeMeSiS News 2017

Newsletter of the ANU-AAMT National Mathematics Summer School

Students enjoying the final dinner at NMSS 2017

EDITOR'S WELCOME

Welcome to the 19th edition of NMSS News - we hope you enjoy reading this next instalment! We are always open to any feedback, submissions or ideas to keep our annual newsletter engaging and relevant across the NMSS generations, so please don't hesitate to get in touch. If your contact details have changed, you can email us your new details, or update them at http://nmss.edu.au/contact-us/.

With our 50th NMSS just over the horizon, I would love for any alumni to send through any photos you may have of your time at the summer school. If you, or another alumni you know, would be interested in sharing some experiences during and post-NMSS over our 50 years, please let me know!

I would just like that take the opportunity to thank all of our contributors this year, and to Leon and Merryn for their patience with my first newsletter as Editor!

Wishing you all a wonderful remainder of 2017!

Kaela Armitage (Editor)
newsletter@nmss.edu.au

FROM THE DIRECTOR

Hi everyone, 2017 was another fantastic and successful year for NMSS. Next year, in January 2018, we will hold the 50th National Mathematics Summer School.

We will have a celebration in Canberra on the day after the summer school finishes, Saturday 20th January 2018, (details to be determined). If possible, during the course of the year we can have state-based reunions around the country for those unable to travel. If you are interested in helping to organise a reunion event in your state, please contact me by email on director@nmss.edu.au. In the meantime, remember that donations to NMSS are tax-deductible and we would love for all alumni to donate $50 for the 50th anniversary (feel free to donate more if you so wish!). Instructions for online donations are on our website at **http://nmss.edu.au/donations** and you get a tax invoice immediately.

Leon Poliadan (Director)

TUTORS IN FOCUS // STEPH WANG

NMSS STUDENT 2006-07, TUTOR 2011, 2016-2017

When I was asked to write a piece on where life has taken me after NMSS, I thought to myself, "why me?". I am currently a lawyer at an international commercial law firm. From one perspective, you could say that my life has taken me as far away from my maths roots as possible. To the point where it would be fair for you to wonder how my story could be in any way of interest to you; after all, science and the humanities are like water and oil.

I was never one of those people who knew what they wanted to be when they grew up, but I knew exactly what I didn't want to be. For example, I knew I didn't want to be a doctor (just the thought of needles makes me feel nauseous). At school, my best subject was maths, but it was not something I thought I could make a career pursuing. However, at the risk of sounding cliché, attending NMSS changed my life, or at least my view on it. I knew, from that summer, that maths was something that existed outside of school and it was something I wanted to continue studying - so I did.

At university, I did a combined science (majoring in maths of course!) and law degree. Looking back, I am not sure exactly why I did the law degree, but for my first five years at university , I wasn't sure I even wanted to be a lawyer. Heading into my fifth year of University, still having not a clue what I wanted to do "when I grow up", I applied for summer internships in law and banking, not knowing of any "maths" summer internships that I could apply for. I won't tell you how many internships I applied for but as the saying goes, all you need is one. In the summer of 2011-2012, I worked as a clerk in the field of intellectual property, specialising in patent litigation. From then, I was hooked. For me, patents representing the technology of the future and having the opportunity to argue whether certain inventions should or should not be patented is a perfect marriage of both my roots in science and law. Five (and a bit) years later, I am still a lawyer working mainly in patent litigation and I am not yet bored! I've had the opportunity to work with some interesting technologies including the discovery of gene mutations which increase risk of breast and ovarian cancer, the first cure for the hepatitis C virus (worth billions!) and the latest in gene editing technology.

I guess the moral of my story is that you never know where the next "yes" will take you. You don't need a 5 year plan to be "successful" - pursue what you are passionate about, do what makes you happy and the rest will work itself out (at least, it did for me … I think).

TUTORS IN FOCUS // MELISSA LEE

NMSS STUDENT 2010, TUTOR 2013-2016

My time at NMSS changed my perspective on mathematics from something that I was reasonably good at, to something that became my passion. After high school, I completed my Bachelor of Science and Master of Philosophy degrees at the University of Western Australia (UWA), majoring in pure mathematics.

When I was in my honours year, I started the UWA Mathematics Union, a club that I hoped would bring together people interested in mathematics in the same way that NMSS did. Today, the club has over 200 members, and last year it won the award for being the best club at UWA, an achievement that I would never have dreamed of when the club first started. During my time at UWA, I was also involved with quite a number of committees and initiatives related to equity and diversity, and improving standards in tertiary education. I am particularly interested in these issues in the context of STEM, and more specifically, mathematics. I have also been lucky enough to do a great deal of volunteer work tutoring disadvantaged primary school children in rural WA, as well as being a tutor during the inaugural Curious Minds program for young women in STEM.

Last year I moved to London to study for my PhD at Imperial College, in a topic related to the group theory and representation theory of finite simple groups. So far, I've met a NMSS alumnus in every class I've tutored or sat in on at the college! I'm really grateful for the way NMSS changed my perspective on mathematics and gave me the opportunity to meet so many wonderful people who have influenced my development as a mathematician thus far.

WORLD WAR II TECHNOLOGY ROUTING UPS

In World War 2, the Allies were faced with a difficult question: what food should we be feeding to our soldiers? This may sound simple, but with so many soldiers to feed, a slight saving in cost per head can significantly reduce overall costs. Perhaps more importantly, you need to make sure that your soldiers are all receiving adequate nutrition. There need to be the right amount of calories, vitamins, minerals, fats, sodium and cholesterol.

So how can this be posed as a mathematical problem? We focus on the decisions that need to be made. That is, how much of each of the available food types will be given to each soldier? The breakthrough comes from letting each of these values be represented by a variable. For example, if there are 77 different food types, any set of 77 non-negative numbers represents a possible solution. We can picture this as being points in 77 dimensional space (don't think too hard about it, we're just going to let the numbers do their work). Now the requirements that the diet contains no more than 300mg cholesterol a day can be expressed as a linear constraint $\sum_i c_i x_i \leq 300$ where x_i is the variable representing the amount of food i delivered and $c_i$is the amount of daily cholesterol from food i.

Each dietary requirement can be expressed in this way as a linear constraint, which removes a section of 3 dimensional space as possibilities. Whatever space is left over we refer to as the feasible region and it represents all allowable sets of food delivery. Now all that remains is to pick the best (cheapest) point. We know it will be at a corner of the feasible region, so we use matrix methods to walk around the corners until we find the cheapest one.

In the first big instance of this to be solved there were 77 food types (and therefore variables) and 9 constraints for dietary requirements. Solving this took 120 person-days of people working with manual desktop calculators (this was before computers). These days, such a problem can be solved in well under a second on a standard laptop.

It turns out that a Russian, Leonid Kantorovich, had invented another way of solving these problems years before, but he was scoffed at and ignored.

The matrix methods developed for solving this type of problem are used to decide how electricity will be distributed along the East coast of Australia.

Another key breakthrough came in 1960 when Alison Doig (now Harcourt) and Alisa Land developed a method for solving these problems with variables that must be integer. Alison Harcourt is from Colac in Victoria and has worked at the University of Melbourne since 1963 (she's done a lot of incredible work and is well worth a Google if you're interested!).

With advances in computing power and methods we can solve much more complicated problems. Consider a delivery company who need to drop off products from a warehouse at your home as well as other people's homes. Which trucks should go where and in what order? How do they ensure that the trucks aren't too full and that they get to everywhere? The answer comes with two separate optimisation problems.

In one, methods related to how your GPS finds the quickest path home for you are used to generate possible routes for individual trucks that meet all volume and weight requirements.

The second problem involves variables that choose which paths to select to find the best combination. Beautiful mathematical properties of the solution to this problem are then used to guide the first problem towards paths that will be most beneficial overall.

This type of method now helps to run airlines, to find paths in your GPS, to plan logistics for deliveries, to design the NBN layout, to run warehouses, and to plan the breeding of soybeans among many other aspects of modern life.

Olivia Smith
NMSS Alumni Lecture 2017

THE E.G. SONG – 2017

(to the tune of 'Sound of Silence')

Hello tutor my old friend,
I've come to talk with you again –
Because a question leaves me weeping
Asked by Norm while I was sleeping,
And division that meddled with my brain
Brings me pain
During private study.

In a highway filled with trees,
We learned of fields like Z3*.
Norm was teaching us arithmetic
With a Martian in the closet;
But then, David Harvey had arrived,
And made us derive
The Riemann Hypothesis.

And the IGs, they calculate
In the tricky mod Norm gave,
And the tutes were long in the morning,
Like the proofs that they were forming,
And the words of the EGs are written on the lecture boards –
They wait for applause,
And are greeted with the sound of silence.

Confusion like a power grows;
Beach balls are supposed to show
How in projective geometry,
Some lines meet at infinity.
But we'll always keep these memories
Of our family
At NMSS.

NMSS REFLECTIONS

I can't deny that NMSS was heaps of fun. The defining aspect was the other students and I enjoyed dipping my toes in some incredible and interesting fields of mathematics I had never seen before.

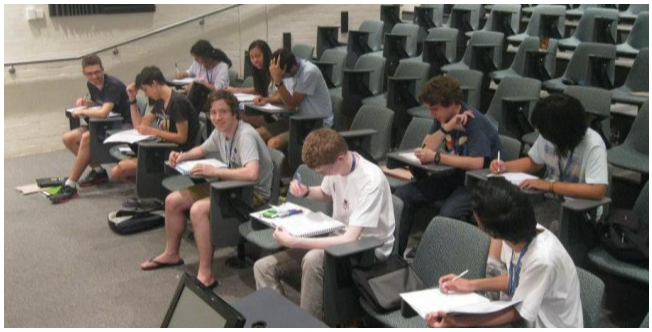
However, beyond the awesome people and intriguing mathematical concepts, my greatest enemy during NMSS was fatigue. I specifically remember one night during private study, a sudden knock on the door and the voice of my tutor jerked me out of my temporary stupor. I collected myself and conjured a question half-related to something I'd been working on earlier. I don't how it's possible that to feel frustrated about a response to a question I didn't intend to ask, but it was how I felt when my tutor answered with yet another question. However, before I knew it, I was alert and applying myself to the newly presented problem – my previous desire to sleep all but forgotten.

These sorts of interactions were the norm with my tutor. I never seemed to be able to 'finish' a problem because there was always something I had missed, something more to study and a plethora of other possibilities I hadn't come close to considering. This was what really excited me – the solution to a problem on a worksheet was always a gateway to five others.

Maths at school is often tedious, repetitive; you're told to do something and you're expected to follow. One of the biggest things NMSS demonstrated that being a mathematician goes beyond crunching numbers and plugging values in some taught formulae – it's involves a lot of creativity and problem-solving and it forces you to think under the presumption that no one else has the answers.

While certainly, a continuous accumulation of sleep deprivation might result in a few mid-study dozes, I can say with confidence that the NMSS experience has shown me that you can never get tired of maths.

Lachlan Pham, Student 2017



I had yet another incredible experience at NMSS this year, particularly with all of the social, academic and leadership opportunities that came with being an EG. In terms of the maths courses, it was great to be able to revisit Norm and David's Number Theory courses for a second time: I was able to see many of the same mathematical concepts from a fresh perspective. The four extra topics which we studied as EGs were particularly interesting and challenging, enabling us to examine a variety of mathematical topics such as Chaos Theory and Cryptography. Of course, another one of the best parts of NMSS is the social aspect. I loved getting to know the IGs and the other EGs as we organised activities such as ice-skating and bowling, played a tonne of board games, and of course, the final night concert was a definite highlight of the two weeks. We enjoyed a fantastic variety of performances this year, ranging from a group rendition of the Sydney Boys' school song, to a Rubik's cube-solving competition, to David Harvey's performance of a song he composed himself! We definitely shared some incredible memories and I'm incredibly jealous of those students who'll be returning to NMSS in 2018.

Taylor Ruber, Student 2016/2017

It wasn't just the content of the mathematics at NeMeSiS that was different: the way in which it was taught was completely new as well. We were frequently forced to develop our own approach to the questions on the problem sheet each day, as nearly anything we asked our tutor would be met with "What do you think?" or "Can you prove it?". The emphasis was not on remembering a method, or even getting the right answer, but developing curiosity and problem solving skills.

Aside from the mathematics, NeMeSiS also provided a wonderful social experience. Many of my best memories from the school are from times spent playing assassin, or puzzling over riddles from the EG's with other students. It was a great opportunity to meet many like-minded people from across the country, who I'm still keeping up with today. In addition, I've met alumni from other years in all kinds of places since 2013, and it's always fun to look back on the school and remember our experiences.

Max Jolley, Student 2012/2013