Paradox

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The Magazine of the Melbourne University Mathematics and Statistics Society

MUMS

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In This Edition of Paradox

Regular Features

Articles

Interviews with MUMS Alumni

by Lu Li

Words from the Editor

Welcome! We at the Melbourne University Mathematics and Statistics Society (MUMS) have voted on past articles of our magazine Paradox that we think would be most interesting and useful to you at this point in your studies. As Term 2 draws to an end and a well-deserved holiday approaches, we do hope you have the time to enjoy this special tailor-made issue of Paradox!

You will find that mathematics at university is rather different to that in the high school classroom and studying it can lead to a whole range of careers. In this issue you will first find the passionate words of our recently-elected President Giles immediately followed by a guide towards figuring out what type of 'real' mathematics suits you. If you are looking for something to read over the holidays, then look no further than our list of books that every maths student should read.

Over the past year, we have also been interviewing MUMS alumni with a variety of backgrounds partly as a way of finding out what people who used to be in MUMS are now up to, but also as a way of learning more about where you can go in life through a love of mathematics. We have compiled them all into one issue for your convenience, and hence you have four very different MUMS alumni interviews to enjoy!

I would like to thank Han, a past President and a regular in the MUMS room, for his insightful (but lazy) guide to undergraduate maths; Stephen, my predecessor, for his useful list of must-read books; all the alumni who agreed to be interviewed for sharing how maths shaped their fascinating paths in life; and especially Lu, a past Vice-President without whom none of the interviews would have been possible.

Due to space and time constraints, we are unfortunately unable to include many of the other wonderful pieces that feature in our regular issues of Paradox, so if you want to find out more, please do visit our archive of past issues on the MUMS website (details on page 2) and read to your heart's content. Moreover, if you have any questions about studying mathematics or at university in general, please feel free to send an email our way. Submissions of your own, including articles and random maths jokes are also more than welcome. I hope you have a great time at the Maths Fair and I wish you all the best in your studies!

Words from the President

Welcome Maths Fairians! I personally hope you are having or had fun discovering a world of maths beyond the tragically limited scope that you can experience in a classroom alone. Maths is about understanding and exploring the fundamental nature of the world or something far more esoteric and abstract, and this is a lot of fun.

I myself particularly enjoy seeing how real world behaviour reflects concepts in maths and how studying these concepts can lead to a better understanding of this behaviour, hopefully solving a few equations in the process to see how we can make things even better.

Others in MUMS spend their time analysing the topology of compact Banach spaces and maps between them (when they talk about it, I spend most of my time looking up what all of the words mean!) but such topics as these (which would normally be described as Pure Maths) are so deep and rewarding that one can get lost in their intricacies, beauty, and subtlety for years.

Maths has many aspects to it but all of them can be immensely interesting when you get past the initial hurdles. We here at MUMS wish to foster the enjoyment of all kinds of maths, both at the university and in schools, but also in the wider community.

We believe that maths has a special place in everyone's life and that people just don't know it and can't see it having been scared off by maths at school. Let's face it . . . sometimes maths is pretty tricky!

We hope that we and others have inspired you to delve deeper into this mysterious world and experience something truly unique. Most of all, we hope you have had fun and will continue to have fun. For example, by reading the rest of this special edition of Paradox! Go on, you know you want to.

> Pure mathematics is the world's best game. It is more absorbing than chess, more of a gamble than poker, and lasts longer than Monopoly. It's free. It can be played anywhere — Archimedes did it in a bathtub.
> — Richard J. Trudeau, *Dots and Lines*

A (Rough) Guide to Undergraduate Maths

What sort of mathematician are you?

At Melbourne University, mathematics is broadly split into four fields: pure mathematics, applied mathematics, statistics and operations research. The question is, what's the difference between these fields? If you're a first year, fresh out of high school (to whom this article is mostly targeted), there's a good chance that the only two fields of mathematics that you're familiar with are *Specialist Mathematics* and *Mathematical Methods*. Which to be quite frank are the most useless titles for subjects ever. You might as well have called them *Maths* and *Harder Maths*. There's nothing particularly *special* or *methodical* about either. High school has hardly prepared you for the diversity and broad utility of university mathematics. So here I'll list just a few basic pointers that may help you with deciding just what sort of mathematician you are.

Pure Mathematics

Are you the sort of person who finds the elegance of mathematics attractive? Do you enjoy proving seemingly useless but nevertheless interesting results? If you answered yes to these questions, then pure maths may be the way forward for you.

In the pure maths specialization, more than any other, you'll discover why maths is regarded as an art as well as a science (though, quite possibly, only mathematicians put it like this). Pure mathematics is about studying the underlying concepts that make all maths work. And besides that, it's just really cool stuff.

The variety of material in the pure maths specialization makes it particularly interesting. You'll find out that solving polynomials isn't just as simple as using the quadratic formula. In fact, you'll even see why there is no quintic formula. You'll discover that a punctured torus (a donut surface with a hole in it) is essentially the same as two circles joined at a point. Just don't tell any bakers that one, it may blow their minds and result in some strange looking donuts later on. These are just tiny fragments of what you'll learn studying pure maths, but just as a small warning, this specialization is not for the faint of heart.

Applied Mathematics

Do you really like formulae? Would you like to see how maths can be used in the real world? And most importantly, do you really *really* like calculus? If the answers to these questions are yes, then you should be looking into applied maths.

Applied mathematics is about trying to model complicated systems and then poking around with the inputs to see how things change under certain conditions. Applied mathematics has applications in just about every field you can think of. In the applied maths specialization, you learn techniques and skills that will enable you to solve certain types of equations which commonly crop up in the real world, such as modeling river flows or how human cells reproduce. Just be prepared for a lot of calculus.

Probability, Statistics, and Stochastic Processes

You see statistics all the time. Figures, percentages and ratios are thrown up all the time in the modern world. But do you ever wonder how meaningful these numbers are? When you play a card game, do you ever wonder, "well that was unlikely, but exactly *how* unlikely was it?" We all know that smoking is bad for you, but how exactly do you *prove* this? If these are things that you've wondered about, then you should be looking into probability, statistics and stochastic processes.

In probability you'll learn how to calculate the probability of certain events happening, and study various distributions occurring naturally in the real world. An important use of probability is its application to statistics and stochastic processes. In statistics you'll learn how to properly analyse a data set. By creating statistical models you'll be able to test the effects of certain variables on others.

Stochastic processes is about modeling random processes that occur in the world. For example, you can model the number of people who walk into a shopping centre. You can even attempt to make money by modeling financial markets, though personally I wouldn't recommend this off just your undergraduate subjects.

Discrete Mathematics and Operations Research

So we all spend plenty of time bagging our the government for being slow, inefficient, wasteful, or more often than not all of the above. But how would you make it better? Do you spend time thinking about how you could make processes faster, more efficient and just better in general? If these questions appeal to you, then you should be looking into discrete mathematics and operations research.

This specialization is all about decision making. And decision making is hard. Just think about a can of baked beans, and the path it travels from the farm where the original beans are grown, to your dinner plate. There's at least a dozen different processes that have to happen before it reaches you. Now the question is, what's the best way to do this? You'd want to reduce time, but also costs, and then on top of that increase quality. All of a sudden your choices aren't all so clear cut. Operations research deals with these sorts of issues in a scientific manner to help with decision making. And with society becoming more complex, and processes becoming more numerous, there's no doubt that this field is important.

Now what?

So maybe I've given you some idea about what the different specializations are. The question that remains is what subjects to do. The best advice I can give is to pick up a copy of the course advice booklet produced by the maths department. It's bright orange and you can pick it up from the front office in the Richard Berry building. If you're a first year, the choices are actually remarkably simple.

First year subjects

In first year, maths students, regardless of your specialization, will take a first year mathematics and statistics package. The first year package is a good little set of subjects that will give you an introductory glimpse into all the fields of maths. You are then able to narrow your focus on any of the specializations. What you pick depends on how you did in high school. Most packages are two subjects, one in first semester, one in second, and there's the option of also taking the breadth subject Critical Thinking with Data.

For students who did Specialist Maths, it depends on what your raw study score was:

- $\geq$ 38 – take Accelerated Mathematics 1 in semester 1 and Accelerated Mathematics 2 in semester 2.
- $\geq$ 27 – take Calculus 2 in semester 1 and Linear Algebra in semester 2.
- $<$ 27 or not Specialist Maths – take Calculus 1 before taking Calculus 2 and Linear Algebra.

After first year

Once you get into second or third year you'll need to specialize into one of the four fields I've talked about above. Because I'm lazy, I'm not going to go into all the subjects but instead refer you to the department's course advice booklet.

Disclaimers, advice and conclusion

As I'm sure my law student friends will tell me, I need to put in a disclaimer thingy here. The material above is all purely my opinion, I can not stress enough that if you are looking for course advice there are people, very friendly and nice people even, in the Maths and Stats Learning Centre (MSLC) who are far more qualified than yours truly to help you out with subject selection. Understandably, some people find it easier to talk to peers, so while we will always recommend that you speak with the MSLC, also feel free to drop into the MUMS room in the maths building and have a chat with some of us. We're also very friendly and nice people!

The field of mathematics and statistics is an enormous field with an incredible variety of content. Hopefully I've given some people an insight into how awesome maths is at uni, and offered some helpful advice. I've certainly had no regrets doing maths at uni, and I encourage you all to do as much maths as possible, though admittedly, I may be slightly biased.

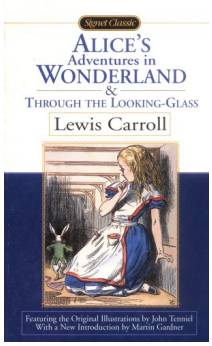
Q: Do you already know the latest stats joke?
A: Probably...

Books Every Maths Student Should Read

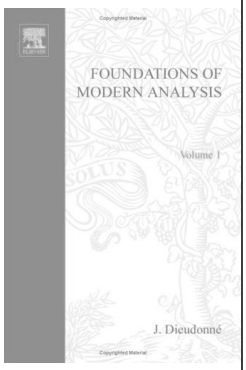
For this edition Paradox surveyed our learned professors and lecturers about their favourite books on mathematics and statistics. The resulting list is eclectic, comprising topics ranging from the history of mathematics to brain-teasers, mathematicians' biographies to seminal textbooks, all of which will provide hours of amusement. Most of these books are available for borrowing at either the ERC (Eastern Resource Centre) or the Baillieu Library.

Special thanks go to Barry Hughes, Owen Jones, Jerry Koliha, Guoqi Qian, Arun Ram and Andrew Robinson for their thoughtful contributions, and happy reading!

Eric T Bell, *Mathematics: Queen and servant of science* (1951)	
	Regarded by some as essential reading for all students of mathematics, this book is for those interested in a thorough yet engaging story of how the field of mathematics came to be. From early beginnings with Euclid to more recent applications of mathematics, this classic is filled with inspiring accounts of how mathematics has buttressed the scientific and technological development of modern civilisation.

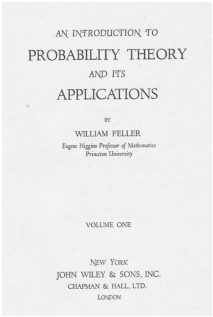
Lewis Carroll, *Alice's Adventures in Wonderland / Through the Looking Glass*	
	Accompanied by Sir John Tenniel's iconic illustrations, *Alice in Wonderland* is a classic novel that has enamoured mathematicians and Common Folk alike for more than a century. Carroll – a mathematician himself – takes the reader through a vivid surrealist fantasy brimming with strange characters in a nonsensical world. And while there are scores of interpretations of the story, a 2009 article by *New Scientist* explores the mathematical allusions in the book (see Melanie Bayley, 'Alice's Adventures in Algebra: Wonderland solved', available online). Note: Tim Burton's recent film adaptation is no substitute for reading the book.

Jean Dieudonné, *Foundations of Modern Analysis* (1969)



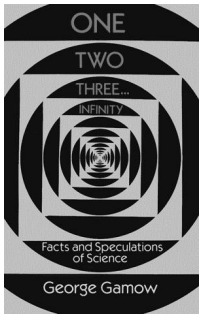
'It is a book without which I could not imagine my mathematical education. The author is the principal founder of the Bourbaki group, yet the book is un-Bourbaki-like.' – Jerry Koliha

William Feller, *An Introduction to Probability Theory and its Applications* (1968)



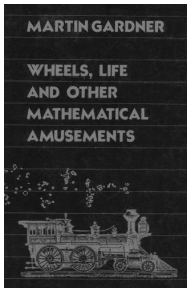
'Now in its third edition, reprinted in 1971 with minor corrections, this book which first came out in 1950 was probably the first decent text on probability written in English. The balance of probabilistic reasoning and analytical techniques is marvellous and though specialists will regard it as dated, and it probably is, I retain enormous affection for it. There is a second volume, which came somewhat later (1st edition 1966; 2nd edition 1971), which contains more mathematical technicalities and is also excellent.' – Barry Hughes

George Gamow, *One Two Three... Infinity: Facts and speculations of science* (1988)



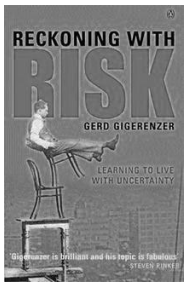
Written in layman's English, Gamow's book has drawn the curiosities of countless budding mathematicians and physicists with its exploration of famous unsolved problems (some of which have been solved since his death) and accessible explanations of big ideas such as 'the size of infinity'.

Martin Gardner, *Wheels, Life and Other Mathematical Amusements* (1983)



Filled with mathematical brainteasers, and spanning a wide range of topics including chess and electricity, Martin Gardner's book is prime entertainment for those who love engaging in thorny mental gymnastics. Perfect practice for the MUMS Puzzle Hunt in April!

Gerd Gigerenzer, *Reckoning with Risk: Learning to live with uncertainty* (2003)

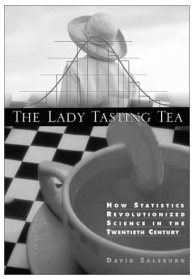


'Gigerenzer is at the forefront of statistical reasoning and cognition. This book is about using statistical tools for thinking in everyday life.' - Andrew Robinson

Godfrey H Hardy, *A Mathematician's Apology* (1948)

Acclaimed as 'one of the most eloquent descriptions in our language of the pleasure and power of mathematical invention' by the New Yorker, Hardy's memoir is a poignant depiction of his fading mathematical abilities at the end of his career, and his profound passion for the field. An inspiring book for undergraduates and practicing mathematicians alike.

David Salsburg, *The Lady Tasting Tea: How statistics revolutionized science in the twentieth century* (2001)



'[A] pleasant and very readable stroll through statistical inventions and controversies of the last 100 years.' – Andrew Robinson

Zhihong Chen: Quantitative Analyst

Zhihong Chen graduated in 2008 with a double degree in Science (majoring in mathematics and statistics) and Commerce (taking economics, finance, and actuarial subjects). He currently works as a quantitative analyst at Goldman Sachs in Sydney.

Why did you join MUMS?

Well, I think it was because I knew a lot of people there. When I was in first year, a lot of friends were from my [International Mathematics] Olympiad days, and they were a year ahead. Given that they were always in the MUMS room, it was just easy to hang out with them there. For the first few years they were always there, and then when they left, I had stuck around long enough to make friends with the newer group.

So basically, the MUMS room was a place to hang out with friends?

Yeah, when I had nothing else to do. Towards the latter part of the degree, when people kind of stopped showing up to university, the MUMS room was always the emergency place! I still keep in touch with them, but less so now that I'm working full-time, and in another city.

What kind of things did you do in the MUMS room?

We went through phases, but games would be a part of it. Chess was in for a while, then we switched to Scrabble, and then Settlers [of Catan]. Of course we did some maths too. Sometimes, we'd discuss maths problems from class.

What was your favourite MUMS event?

Probably SMO (School Maths Olympics). It was good fun organising a competition and raising the profile of maths for high school kids.

How else were you involved in MUMS?

I think in first year I helped out with the problem setting for UMO (University Maths Olympics). I didn't really hold any positions in MUMS. I was second year rep when I did a lot of the stuff for the SMO. I don't think you need positions to contribute. There were some reps who never showed up. Ever [laughs]!

What happened after that?

Well, I think in later years you start worrying about jobs, internships and stuff like that, so I found myself less inclined to do anything serious for MUMS in fourth and fifth year compared to the earlier years. But I still hung around and helped where needed.

So tell me about your current job at Goldman Sachs. What kind of things would you do in a typical day?

It's a bit hard to describe, but just about all investment bank graduates are called 'analysts'. This is basically the most junior rank. But a more detailed description of my role is probably a quantitative analyst. I'm the guy who uses maths to solve financial problems. In a nutshell, I structure trade ideas using financial instruments. I also analyse historical data, and sometimes work on mathematical models that we use to price up financial instruments.

Would you say that your maths major has been useful in your current role?

Yes, although I wouldn't say that any particular thing I learnt at university is that useful. It's more about developing the general skill set. Maths students are meant to be good at problem solving, and that's the most useful thing to take into the type of job that I'm in.

So you don't use any particular maths knowledge in your current role?

As a maths major, you learn a lot of things that will never be used in industry. But having learnt it preps you in other ways. Basically, it teaches you to think outside the square and to know how to understand complexity.

What about the usefulness of a maths major for finding jobs generally?

I don't really know. I know that in finance, people with strong maths backgrounds generally have many options if they're resourceful enough to look.

What do you mean by that?

I mean exactly that, Lu. There's no other way to say it [laughs].

Is this what you imagined yourself doing when you were at university? I remember you always thought you'd do a PhD in maths.

I think most people end up in places they didn't expect while they were

still back at university. I think it's good to be open-minded to opportunities and experiences that are offered to you, and not focus on a particular set path. So no, I didn't imagine myself doing my current job while I was at university. But you know, maybe in a few years I'll be doing something else that I couldn't have imagined now.

Now, I happen to know that you have rubbed shoulders with many famous people. I am referring specifically to Julian Assange and Terence Tao. Can you tell us about that?

Well, with Julian, I kind of knew him before he became the person he is today. I didn't really have much to do with him. He was a member of MUMS but never more than an acquaintance. Back in the day, he was very much into maths and problem solving. With Terence, I was his student in one of his graduate classes when I went on exchange to UCLA (University of California Los Angeles). There were around twenty of us in the class. He taught graduate level analysis, a first-year PhD subject.

What was Terence like?

I felt he was relatively shy, but a very organised lecturer. He was brilliant. And he looked very young. His teaching assistant was his PhD student, but you could be forgiven for thinking that Terence was the PhD student.

Did you talk about anything in particular with him?

I had a brief chat with him after I had finished the course. He always opened his office for students who wanted to talk to him, especially those doing his course. I asked him what it was like being an academic versus working in industry. He said that it's really up to the individual and what they want. He mentioned that his brother was working in Google and was pretty happy there. But he thought that academia was a good life as well.

You asked for his autograph—how did you work up the courage to do that?

I just asked him. He does get a few requests here and there. There were a couple of students who came into our class after the last lecture and ambushed him for a photograph. I thought the autograph was enough. I didn't feel the need to prove that I was in his class.

Norm Do: Mathematician

Background

Norm Do has been an active member of MUMS since 1998. He graduated in 2002 with Honours in both Science (majoring in mathematics) and Engineering (electrical engineering stream), and completed his PhD in mathematics at the University of Melbourne in 2009. Soon after, he commenced a postdoctoral fellowship at McGill University in Montréal before returning to the University of Melbourne as an Australian Research Council (ARC) Postdoctoral Fellow in 2010.

MUMS

Why did you join MUMS?

I always liked maths and pretty much knew I wanted to study it at uni. I was lucky enough to know the MUMS committee through school friends and thought they were cool (albeit in an uber-geeky way)! After I joined, it turned out to be pretty fun! It's important to remember that MUMS offered, and still offers, more than just events. It provided an environment for mathsy activities (like deciphering lectures) and was an opportunity to socialise with people who had similar interests, not necessarily maths-related.

How have you been involved in MUMS?

Previously, I've been the First Year Rep, Second Year Rep, Postgrad Rep, Education Officer, and Paradox Editor (and possibly even more)! I also helped out with the SMO (Schools Maths Olympics) and the UMO (University Maths Olympics). Since I've been back in Melbourne, I've given two MUMS seminars. Oh, and I always attend the other MUMS seminars for the free food (and sometimes, the educational value too)!

You've been involved in MUMS for over *ten* years! Have there been many changes over this time?

Well, MUMS keeps adding to their repertoire of activities. For example, back in the day, Puzzle Hunt didn't even exist on the MUMS calendar!

I think the MUMS Committee has also become more diverse in terms of gender and background. In my first year with MUMS, the committee seemed to be made up of people from only two schools!

Oh, and the new room is definitely better...it's more open and just a little less stinky than the old one. The only downside is that when I enter the MUMS room now, I'm almost certainly the oldest person there! Back in the day, our room was a dark, windowless corridor. It was so long and narrow that we used to play two square and cricket in there. These days, it's been snazzified by BHP and they're probably using it for more dignified purposes!

And how has Paradox changed?

You know what, Paradox has not changed at all! I'm surprised at how similar Paradox has been over the years...it's been consistently awesome! The Editor still seems to be using the same template we used all those years ago.

Actually, now that I think of it, there is one thing that's changed and it was introduced by me — staples! I was the first ever official Paradox staple boy...which means that every issue of Paradox was stapled by me. In fact, the stapler in the MUMS room belongs to me.[1] I got it as a present the first year I was anointed staple boy. I think readers have me to thank for their Paradoxes not falling apart in their hands!

What is your favourite MUMS event?

Probably the UMO, because I always get something out of it — first prize [laughs]! My team won the UMO last year, and I hope to win again this year if my team, the Contravariant Funksters, perform up to scratch![2] I've participated every year since 1995, apart from a few times when I was overseas or helped write the questions.

Have you really won first prize every year?

Ok, no, that's not true...but it's close enough! Look, I'm getting old, you can't expect me to keep up with all those spry youngsters.

Career

Why did you choose to become a mathematician?

I've always been drawn to maths, even as a child. In grade four, my primary school teacher would give me a tougher textbook and tell me to sit at the back

[1] The current Paradox Editor became so sick of struggling with this stapler that he ended up decommissioning it and bought another stapler that looks almost identical to the original one, except this one is much, much better!

[2] Ed note: They didn't finish in the top three in the year of this interview.

of the class and read it... and for me that was a treat! I feel like my mind has always been drawn to the structure and beauty of maths. I've always been driven by curiosity, be it in maths or other areas. But for most of my life I didn't know what a mathematician actually does.

Now that you *are* a mathematician, can you explain what they actually do?

I'm still working that out [laughs]! Well, to give you an idea of what I've been doing this semester: I spend a quarter of my time teaching undergraduates [Calculus 2], a quarter of my time going to graduate lectures and seminars, a quarter of my time checking my email [laughs], and a quarter of my time actually sitting down with pen and paper trying to solve real original research maths problems.

What problems are you currently working on?

I like to work on problems from combinatorics, geometry, or physics, but preferably all three! The problem I'm currently working on is this: someone gives you a bunch of polygons, and you want to glue them together to make a surface. For example, four triangles can be glued together to make a tetrahedron, which is a very simple example of a surface. I'd like to know how many ways there are to do this in a general setting. It turns out the numbers that arise turn up in other areas of mathematics, as well as theoretical physics.

What is it like being a mathematical researcher?

As an academic doing maths, the lifestyle is very good. By that, I mean that the environment is great. Also, being a mathematician is not an evil job. You're generally working through self-motivation rather than having a boss telling you what to do. It's pretty liberating to be able to do whatever you like - you make up your own hours, and no one tells you to stay back until 7 pm. But I usually end up staying back that late anyway if I'm really keen on a problem or really excited about a paper I'm reading! There are many opportunities for travel, and in this line of work you come across really interesting people, as you can imagine! They obviously love maths but are usually keen on other activities as well.

What is an 'evil job'?

In general, for most jobs, it's hard to say what effect your job has on other people since the effect is often so long-range. On the other hand, in math-

ematics, your interactions with other people are very natural and pleasant. When you teach, you're helping others; when you collaborate, you're working together on a problem. It's a career that's really driven by curiosity. Your impact on other people is quite immediate and generally very positive — although some of my calculus students might beg to differ!

Who are the interesting people you have met on your travels?

I've come across various Fields Medallists... one example is Shing-Tung Yau [1982 Fields Medallist]. I also know mathematicians who are circus performers — they work on the weekends busking on the streets. I know others who are in heavy metal bands... actually that's not that uncommon really. A colleague of mine paid people $20 to turn up to his maths lectures dressed as the 'mathematician of the day'. Sometimes, it seems to me that I'm the only normal mathematician in the world!

Is this what you imagined yourself doing?

When I was a student I was pretty short-sighted — I didn't think about where I would end up. I'm glad about that, because if I had thought harder I might have gone into a more vocational degree. I like being an academic, but I know that if I want to move into the real world, there are millions of jobs waiting for someone numerate like me!

It sounds like job prospects for someone studying maths are quite good?

Well, I recently made an appearance as the token academic (out of seven speakers) at a maths careers evening held by the [MU Maths] Department. One thing was very apparent to me from listening to the other speakers. Mathematics, particularly the ability to think logically as well as creatively, is very much appreciated in government, industry, and finance... and if you're willing to look, it's easy enough to get a job.

I imagine that some would be worried about becoming a mathematician because it may not pay as well as a job in industry. Your thoughts?

I seem to be doing all right... although I'm also lucky enough to be married to a doctor! To be honest, I think I get paid more than I deserve... but don't tell that to the ARC though [laughs]! In Australia, academics generally get paid reasonably well. It isn't comparable to working in finance... but maybe per hour it might be.

What are your plans for the future? Do you envisage yourself in academia for a long time?

My current post lasts for two more years, and then I'm back on the job market, which is one of the worst aspects of being an early-career mathematician. I may have to move to another country temporarily, but that's also pretty exciting from my perspective. My current plan is to ride the academic wave for as long as possible. I can't think of anything else I'd rather do at the moment!

Random and Interesting

I've been stalking you a bit and noticed that you are involved in many maths activities and camps?

That's a bit creepy... but yes, I've been kind of busy! I used to teach motivated high school students; I teach at NMSS (National Maths Summer School); I've been involved in Australia's Maths Olympiad Program since I was a student; and hopefully I'll be starting up a mathematical radio segment with the ABC (Australian Broadcasting Company) soon!

These activities aren't a part of my job, but my job gives me the flexibility to participate in all sorts of extracurricular activities. Teaching students is one of the things I love, and what makes it more exciting is if they're keen and talented.

Have there been any students you've taught that really stick out in your memory?

Julian Assange? He's the only one who's gained notoriety — there's no-one else really who can compare to that. I tutored him while he was in first year... he was obviously very intelligent and thoughtful. Usually I don't interact with students a lot after class, but I got to know him through MUMS. We spent countless hours talking in the MUMS room about maths, education, and lots of other things. Of course, conversations about politics did come up as well! I certainly considered Julian a friend but I don't know whether I'll see him again any time soon. Some old MUMS people got together and sent him a birthday video for his last birthday (obviously I didn't see him in person) and I heard that he appreciated it!

What was the video about?

I can't tell you that — that's classified information. Just joking... it was just a few of us wishing him happy birthday and singing the song very very badly!

Now, I heard that you met your wife at NMSS?

Yes, I met my wife at NMSS, or 'nerd camp' as it's often known, while we were both still teenagers. I have to say, I wasn't expecting to go to nerd camp and come back with a future wife, but there you have it! That's what happens when you put a bunch of like-minded teenagers in the same room! It's weird how things work out — who meets their partner at nerd camp?! Actually, it happens a lot more often than you probably think!

Then you pursued a long-distance relationship for seven years! That is quite amazing...

Around the time I met my wife-to-be, I also became acquainted with the internet... so I spent far too much time talking to her on ICQ (if you know that that is) [an instant messaging program popular before the days of MSN]! I also managed to clock up a fair few frequent flyer points over those years. Most of my friends thought she was made up; even after they met her they told me I didn't have a chance with her (or anyone else for that matter)! And now we've been married for nearly three years... but it feels like twenty. Just kidding!

Andrew Kwok: Strategy Analyst

Background

Andrew Kwok(star) is a former member of MUMS. He studied at Melbourne University from 2003 until 2008, graduating with Honours in a Bachelor of Commerce (majoring in Actuarial Studies) and a Bachelor of Science (majoring in Statistics). After completing two internships in Hong Kong and a graduate program at AXA in Melbourne, he now works with AMP (which merged with AXA) as a Strategy Analyst in Sydney.

MUMS

Why did you join MUMS?

I'd kind of been involved in it since high school. In Year 9, we participated in the SMO (School Maths Olympics) and came first that year, beating Scotch [College]. We had a healthy competitive rivalry with Scotch all the way until Year 12. When uni started, I became more involved in activities and eventually became first year rep, then Treasurer the next year (2004) and then President the following year (2005). Also, I already had friends there who were closely involved in MUMS, through my IMO (International Mathematics Olympiad) training days.

Did you really bribe the first years to win MUMS presidency? No, I remember you were wildly popular in MUMS. Do you want to tell me what that was all about?

I don't know why [laughs]. High grades? Most people were friends from high school whom I knew well. I have no idea.

Yes, but your nickname was KWOKSTAR! Does it have anything to do with the fact that your average grade is 99?

[Laughs] No, it's not that high! Let's say around the mid 90s . . . it's harder to score high marks in commerce, especially non-maths ones.

What did you get up to in the MUMS room?

Sometimes we played games, sometimes we did work, sometimes we just hung out and chatted. My favourite MUMS event was probably the UMO (University Maths Olympics). The best thing about MUMS is the friends you make, and all the activities that happen throughout the year. The MUMS room is just a fun place to go where you can hang out!

Career

Tell me about your internships in Hong Kong.

The first was with a local consulting firm, the second was actuarial consulting with a multinational firm. The first internship gave me my first real experience of working in an actual firm. Since working is so different from studying, you quickly realise there's all these other skills that you need. I learnt a variety of skills including communication, writing reports, etc.

Once you have some work experience, you find it much easier to get work experience at bigger, multinational firms. My first consulting role helped me gain the actuarial consulting role as part of the second internship. That internship was awesome! I had the opportunity to apply the actuarial knowledge I'd learnt at uni, learnt a lot about financial markets across Asia, developed more technical skills such as Excel and Database and also made a real contribution on live projects.

Why did you leave Hong Kong for the graduate program at AXA?

Melbourne was the headquarters for AXA's Asia-Pacific operations, so I believed there would be a lot of different opportunities available working in the head office. They have a really good graduate program: it's a three-year program with five rotations. Each rotation is a full-time role, so straight away you're doing real work and learning a lot on the job. They have a strong support program to continue with your actuarial examinations. In addition, the culture at AXA felt right for me. There was also the opportunity to rotate to Hong Kong!

Which rotations did you choose, and what did you do in each?

In total I did three rotations: two actuarial rotations (one in finance, one in pricing), then one rotation in Group Strategy.

The first rotation was in the Finance Department where my role involved calculating profits for AXA's income protection business in Australia and New Zealand. This is a type of life insurance policy that provides you income if you're unable to work for a period of time. During reporting periods, I would run projection models to estimate the future claims that we'd likely need to make compared to the revenue we were likely to receive in the future. Based on these long-term projections, I could then estimate the profit earned during each period. I also assisted in writing regular reports to provide more detailed analysis and commentary on the experience. During non-reporting periods, it'd be a matter of helping various teams perform ad-hoc analyses as well as improve projection models and overall processes to increase efficiency.

The second rotation was in the Product Department where I assisted in pricing and risk management for a capital guaranteed product called North. The idea of the guarantee is that if markets go up, your investment will also go up, but if the markets go down over a period (usually 1 year or 2 years), then the investment will stay flat. In return for receiving the guarantee, the investor

needs to pay a fee. Part of my role was assisting the team in calculating what fees we needed to charge to ensure that we could cover the guarantee and other costs associated with managing the product. This area requires quite complicated postgraduate mathematics in areas such as stochastic calculus in order to calculate the fee, since you need to allow for a large variety of possible future scenarios.

At the moment your permanent role is with strategy. Why did you prefer that rotation?

There were a variety of reasons. One of the benefits of the graduate actuarial program is that they encourage you to try one rotation in a non-actuarial team. So I decided to give Strategy a try. While the actuarial rotations were very analytical and focused on particular areas, Strategy gave me a high level overview of the company, where I needed to understand how each part of the company operated. It provided a good opportunity to meet people from across the business. I still had the opportunity the continue developing analytical skills (being an actuary by profession, they trust that I have strong analytical skills), but I was also able to improve other skills including stakeholder management and strong communication skills through writing reports and preparing presentations.

During my rotation in Strategy, AXA sold off their Australian and New Zealand businesses to AMP. When the merger happened, AMP offered me a permanent role as a Strategy Analyst in Sydney, where I've been working since July last year.

Does one have to train as an actuary to do what you do, or can they just study maths?

For the finance and pricing rotations, it is important to have strong actuarial knowledge and skills. During these rotations, I continued studying for actuarial examinations in order to qualify as a Fellow of the Institute of Actuaries of Australia (FIAA) and as a Chartered Enterprise Risk Actuary (CERA).

In Strategy, you'll find people working from a variety of backgrounds by no means limited to actuarial since this work requires a variety of skills, such as strong communication (both written and verbal), the ability to think strategically as well as strong stakeholder management and negotiation skills.

And does studying maths help with that? Before you said that studying was very different to working.

Not really, actually! Studying mathematics can help you develop strong analytical skills; programming is also useful. Analytical skills including problem solving are useful, but other skills are equally important, such as strong interpersonal skills, time management, communication etc. You can't be a brilliant analytical person but find it difficult to communicate your findings with others. People need to be able to work with you on a regular basis.

So learning maths at uni encourages analytical and problem-solving skills that are employers seek, but you can't just be a bookworm?

Yes, strong analytical skills and great academic results may get you to the interview stage (plus if you have some work experience it always helps) but often it's the other skills that you display during the interview stage that will help secure you the job. Have a personality! I think it's a combination of competent technical knowledge (in whatever field you're in) and whether you'd think they'd work well in your company (which is partly a gut feeling). Working in a company with the right culture is important.

I'm sure final year students will appreciate your tips. So why did you study maths at uni?

I was interested in maths and I was good at it in high school. But I always wanted to work in a company and commerce was an area that interested me. Actuarial was a good compromise between wanting to work in a company and doing something analytical. For people who want to study commerce but enjoy mathematics, I think finance or actuarial studies is a good option.

Random and Interesting

Did you ever go on exchange?

During uni I started learning Japanese, and became more interested in Japanese culture. Hence, I went on exchange to Tokyo University in Japan to study Japanese language, Japanese linguistics, and international relations. I strongly recommend going on exchange! For me, it's definitely been one of the most fun times of my life so far. There were heaps of awesome experiences, I made many great friends from across the world and got the chance to immerse myself in a completely different culture while developing my foreign language skills. I think you also develop a broader, more international perspective.

Why do you come down to Melbourne to get your hair cut? Are the haircuts in Sydney really that bad?

[Laughs] That's more out of convenience! I come back to Melbourne on a regular basis, sometimes for work, sometimes to visit family. My hairdresser in Melbourne is a family friend.

I hear you are quite popular with the ladies at AXA . . . your family friend must be really good!

No comment! I think your questions are starting to get sidetracked . . .

Damjan Vukcevic: Statistician

Background

Damjan Vukcevic is a former President of MUMS. He studied at Melbourne University from 2001 to 2004, graduating with a Bachelor of Science (Honours) degree, majoring in pure mathematics and statistics. Damjan then went on to complete his PhD in statistical genetics at Oxford University, and is now employed as a statistician at Experian Hitwise.[1]

MUMS

How were you involved with MUMS?

I feel like I was involved before I even began uni! During high school I participated in the Maths Olympiad training camps and the National Mathematics Summer School. Through both of these I became friends with many people who were already in MUMS. I used to come to the MUMS room once a week to meet with Chaitanya Rao[2], my mentor for the IMO [International Mathematics Olympiad] team (I was a Reserve Member in 2000). It felt strange coming to uni in my school uniform, with everyone else dressed much more casually.

From then on I felt like I did the standard MUMS thing: rose through the ranks, did a year of presidency (2004), and then gracefully bowed out. It's a nice cycle. I got to do everything from chalking and lecture bashing, to

[1] Editor's note: As this interview went to print, Damjan commenced a new job with the Murdoch Children's Research Institute, starting up a new Statistical Genetics group.

[2] Chaitanya Rao was co-President of MUMS in 1998.

shaping the entire events calendar and trying new innovations. We ran the inaugural Puzzle Hunt in 2004. It was an ambitious project that required the dedication and combined creative powers of the whole committee. We were thrilled that it was so successful in its first year and I'm excited to see it still going strong almost a decade on.

What was your favourite thing about MUMS?

It was the one place I found where people were willing to discuss pretty much any topic. Mathematics was a common interest, of course, but there was a diversity of interests and people were happy to share their thoughts and ideas.

What was your favourite MUMS event?

Definitely the Maths Olympics (both of them)![3] They are fun and intellectually challenging, and I think it is amazing that they involve so many different people, from high school students to professors, all working together on the same activity. I wonder if any other event at uni can lay claim to that?

Education

Why did you decide to drop your Engineering degree?

It was mainly because I wanted to do more mathematics subjects than the double degree would allow, and I didn't want to overload heavily to do it. I also had a closer look at the Engineering subjects and talked to some friends who had already been through them, and decided I would probably find the maths subjects more interesting.

When did you first become interested in maths?

I attended my first Maths Olympiad training camp in 1998 and I think it changed my life. Before that I was just coasting along at school. The Olympiad programme showed me just how exciting maths really is! It also put me in contact with others like myself for the very first time. The same was true of my experience with the National Mathematics Summer School. With both of these programs, I continued my involvement as a tutor and lecturer, and found it just as rewarding as being a student.

[3]Every year, MUMS runs two Maths Olympics: one for students, and one open to everyone at the University.

How did you decide on your majors?

My third year majors were in pure mathematics and applied statistics, which seemed to be an uncommon combination from what I saw. Initially my focus was on pure mathematics, since that's what I was interested in and enjoyed doing. Then in second year I discovered probability and statistics, and the love affair grew from there. This field has strong mathematical foundations, yet still allows me to work on applied problems in many different fields. I was also impressed at its sometimes almost magical ability to solve certain problems.

For any budding statisticians out there, I highly recommend doing pure maths in addition. The foundations of statistical methods are built on some quite sophisticated mathematical ideas and it definitely helps to have a firm grasp of them.

What other advice would you give to current statistics students?

- Tackle both the theoretical and applied aspects of statistics while you are a student. Eventually you might specialise in only one of these, but having a good knowledge of the other is a great benefit.
- Start analysing *real* data early on. That's the best way to get to grips with practical issues. Assignment problems often don't expose them well enough.
- Learn to program. Computers have more than revolutionised statistics; they have *enabled* it. They will be an indispensable tool for the rest of your career. However, even specially designed statistical software only gets you so far before you need to start tweaking and customising, and so programming skills are essential if you want to take things further.
- Collaborate with others. We spend so much time at school and uni working on our own, but to solve real world problems we need to work together. This is particularly true for statistics, since you will usually be trying to solve other people's problems, and will be even more important in the future as we start seeing very large datasets emerge in many areas. Even if there is little opportunity to do this formally at uni, you can learn the same sorts of skills by, for example, joining the MUMS Committee!

What did you do for Honours?

My honours research project was in bioinformatics with Terry Speed at WEHI (Walter Eliza Hall Institute). By that point I was focusing mainly on statistics subjects. I developed a statistical model for a certain class of proteins from one of the malaria parasites, which was of interest at the time to the biologists at WEHI. It was my first taste of real science.

Tell us about your PhD at Oxford University!

While I was doing my undergraduate degree, many people told me that I should go overseas on an exchange semester. It was good advice, but life in Melbourne, and Melbourne University in particular, was so fun and involving that I was reluctant to give it up. However, as I neared the end of my degree, and as a number of my friends slowly departed Australia to do PhDs overseas, I decided my time had come.

Oxford is a fantastic place to study, in so many ways. It is full of bright students and excellent academics; famous visitors frequently come to visit and give talks, and of course the countless picturesque buildings and historic traditions are always a treat. I feel sorry for all the tourists who visit. All they get to see is the college buildings (and often only the outside), but the magic is all in the people and their interactions. That's the *real* Oxford experience. Studying overseas was a marvellous learning experience. Definitely do it if you have a chance!

You also managed to get a *Nature* publication out of your PhD — you must have been excited! What was it about?

Our project was a large collaboration between multiple research groups across the UK. The whole project involved about 200 researchers. Our group of twelve at Oxford formed the majority of the statistical analysis group. It was my first experience at working with so many people and with such a large dataset.

The project itself was a pioneering study of the genetic factors underlying a number of common human diseases, including diabetes, heart disease, arthritis and a few others. Taking advantage of the latest in genetic technology, we were able to compare the genetic makeup of about 17,000 individuals and look for mutations that made you more likely to get one of those diseases. It was the first study of its type at that scale and it was a success. We even made the 6 p.m. news on the day we published, so yes, it was very exciting!

Career

How did you decide on what you wanted to do in your career?

Well, that's been as much a product of serendipity as it is of deliberate choice. I make an effort to meet people, get advice and recommendations, and then grab opportunities that come my way.

Tell me about your current job as a statistician at Experian Hitwise.

After five years in Oxford, I wanted to return home. I missed my friends and family, but also our lovely sunny weather!

When I started looking around for job opportunities, this one came up and looked interesting. It combined many of my interests: statistical modelling, data analysis, working with large datasets and working in teams. The company collects data and reports on internet browsing behaviour. If you are familiar with TV show ratings (by Nielsen), then you can think of what we do as similar to that, but for the Internet.

Remarkably for a company whose product is statistics, I'm the only statistician in the company! My colleagues come primarily from a software engineering background and I'm learning a lot from them. Hopefully they are learning from me too.

What do you do in a typical day at work?

On a good day, I might be developing a new estimation method, which would involve reading papers, nutting out some ideas, and trying them out with some data. Eventually I would program a prototype, and present the results to my team and the product managers.

On a less ideal day I would be helping to investigate issues with our data and software, trying to determine if they are caused by bugs, sampling biases, missing data, or something else, and then working out how to fix it.

In any case, there is always a lot of interaction with other people, whether it be through meetings, presentations, or just informal discussions. Being the only statistician there, I end up working with many people across the company. I've learnt that applied statistics is a team sport and that working in teams is much more fun than working on your own when you've got the right team.

You've had quite a diverse range of projects throughout your education and employment!

During Honours I was working on bioinformatics, at Oxford it was statistical genetics, and now it is 'web analytics'. It is all statistics under the hood, and underneath that I can feel my mathematical heart beating!

What are your plans for the future?

To keep learning, work on interesting problems, maintain links to both industry and academia, and promote statistics as a profession.

Random

You're involved in a lot of sporting activities!

I like to stay active and so have done a mixed bag of sports. I was keen on Taekwondo early on in my undergraduate studies and did it for a few years. I also played volleyball both here and in Oxford, and now go running regularly.

However, what I enjoyed most, and still do, is dancing. Initially I was too shy for anything like that, but once I got dragged along to a dance class (a common route for many of us), I was hooked. Pretty soon I was dancing most days of the week, and eventually I spent more time at dance classes than at lectures. The Dancesport Club became my second home (overtaking the MUMS Room). Later on, I even started dragging MUMS friends along. I'm pretty sure that at one point at least half the MUMS Committee were also dancers!

Would dancing happen to be your favourite sport because you met your wife there?

Haha! Yes, it's one of those stories. I was a dancer from Melbourne and she was a dancer from Monash, and one day there was a big, magical joint dance ball...

Three statisticians go hunting. When they see a rabbit, the first one shoots, missing it on the left. The second one shoots and misses it on the right. The third one shouts: "We've hit it!"

Which is Hotter: Heaven or Hell?

The temperature of Heaven can be rather accurately computed:[1]

> The light of the Moon shall be as the light of the Sun and the light of the Sun shall be sevenfold, as the light of seven days.
> — Isaiah 30:26

Thus, Heaven receives from the Moon as much radiation as we do from the Sun, and 7×7 (49) times as much as the Earth does from the Sun, or roughly 50 times in all. The light we receive from the Moon is 1/10,000 of the light we receive from the Sun, so we can ignore that...

The radiation falling on Heaven will heat it to the point where the heat lost by radiation is just equal to the heat received by radiation, i.e. Heaven loses 50 times as much heat as the Earth by radiation. Using the Stefan-Boltzmann Law for Radiation and assuming that the temperature of the Earth is around 298 K (25 °C), the temperature of Heaven is found to be 798 K (525 °C).

While the exact temperature of Hell cannot be computed:

> But the fearful, and unbelieving... shall have their part in the lake which burneth with fire and brimstone.
> — Revelations 21:8

But a lake of molten brimstone means that its temperature must be at or below the boiling point, 444.6 °C. Therefore, Heaven at 525 °C is hotter than Hell at 445 °C.

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[1] From *Applied Optics*, Vol. 11, A14, 1972.