

CoIAUMS Space

# International Women in Mathematics day

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NEWSLETTER OF THE ADELAIDE UNI MATH SOCIETY

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## More Than Just Mathematics

As I looked at the professor, his face got redder and redder. His lips pursed and he grew a few inches taller. Then he looked me in the eye and said "Well young lady, if you don't like English, what *do* you like?". I didn't realise that, in that moment, offending the Head of the English department was about to send me crashing into a career I had never even dreamed of.

On that day I was changed from a Bachelor of Arts into a Bachelor of Science and enrolled in Calculus. Now I know, if you're reading this, you are an incredible sort of person that has probably leapt into science already - but I was not one of those. And I could see no future in it. I was creative and expressive and artistic... So a career in mathematics was not going to suit me at all.

Alright. You know where this story is ending already so let's skip to the reason I'm writing it. Maths is phenomenal. It is diverse and crazy and beautiful and so many other things as well. And maybe you are one that see's it's beauty – but maybe you aren't. And maybe you can see a future where you use maths joyfully – but maybe you can't. And this message is probably for those of you who are wondering just what you might do with this crazy maths stuff that you're spending so much of your time trying to do.

I want to tell you that your value lies in more than your ability to solve equations or code. So many careers in mathematics require more than

that. So think about the *other* skills you have – graphic design, communication, creative writing, even your sporting prowess and musical skills! What sort of career could you build that uses those *and* maths? Where could they take you? Analytics headquarters for the AFL? Diversity team leader at KPMG? Data visualisation curator or designer (you know, I know some very successful business that do this using Excel!)? Challenge yourself to dream outside the box and look for ways to bring all of those incredible parts of you together while leveraging the skill so few people have but so many industries need – mathematics. You will be amazed at the diverse opportunities that await you.

For me, a career in academia has meant I can be my expressive, creative self in ways I never expected. From explaining concepts for my students through to clear, unbiased summaries for my collaborators, I regularly use my communication skills to make impact. And creatively, data science enables opportunities to break through tradition into new realms of analysis and visualisation. I improve the lives of others in medicine, forensic science and through defence whilst simultaneously teaching the next generation of scientists who will change our world (that's you, you know). Did I think Maths would bring me here? No way! But I am so glad it did.

- Dr. Melissa Humphries, PhD, BSc (hons)

### Why May the 12th?

May the 12th is recognized as International Women in Mathematics day in honour of Maryam Mirzakhani, the first woman to have been awarded the Fields Medal. Mirzakhani was awarded the medal in 2014, for her work in dynamics and the geometry of Riemann surfaces and their moduli spaces. The 12th of May was Maryam Mirzakhani's Birthday.

# Word2Vec

As mathematicians, we like to work with numbers. Numbers are fun! We know what to do with numbers. We can add, subtract, multiply, divide. . . But what do we do with text? We can read it, but if we have large amounts of text, this can be impossible. The next best thing is to turn it into numbers!

One method of doing this is using Word2Vec, an algorithm to learn word embeddings from a large corpus of text. I won't bore you with the details of how these vectors are created (this is left as an exercise for the reader), but it is very cool and if you're interested, Julian Gilyadov has written up quite a good explanation of the process at <https://israelg99.github.io/2017-03-23-Word2Vec-Explained/>.

Word2Vec automatically produces informative word vectors from text using a neural network. These word vectors have surprisingly meaningful relationships which can tell us a lot about the words themselves.

Firstly, the cosine similarity between any two word vectors is a good indicator of how related two words are. The vectors that have the highest cosine similarity are generally words that we might consider to be synonyms. For example, the words with the highest cosine similarity with the word "frog" are:

- frogs
- toad
- litoria
- leptodactylidae
- rana
- lizard
- eleutherodactylus

It is obvious that the word "frogs" is very similar to "frog", but the word2vec model also picks up several terms that the general reader may not be as familiar with. Litoria, leptodactylidae, rana, and

eleutherodactylus are all genres or families of frogs. This is a very clear relationship which may not appear obvious to people who do not specialise in the field despite being easily picked up by the algorithm.

A surprising feature of word vectors is that addition and subtraction generally hold as one would expect. A very common example is that

$$\text{King} + \text{Woman} - \text{Man} \approx \text{Queen}.$$

This seems intuitive, and one can do this with many simple words with obvious relationships between them.

Using this feature, we find see Word2Vec is particularly strong at predicting word-pair relationships such as country-city, or singular-plural relationships. These word pairs are written as relationships of the form "– is to –, like – is to –". For example, "France" is to "Paris" like "Italy" is to "Rome", and "frog" is to "frogs" like "mouse" is to "mice". These pairs are roughly the same position apart, so we can think of this as adding a new vector which translates country vectors into their capital cities, or singular nouns into their plurals. This can also be written in terms of vector addition and subtraction as we had above. We see

$$\text{Paris} - \text{France} + \text{Italy} \approx \text{Rome}.$$

Aside from just having interesting properties, the Word2Vec vectors also have a wide variety of practical uses. Due to the model's ability to pick up relationships well, it is useful for discovering hidden relationships between terms, or generating product recommendations but can also be used for a wider range of natural language processing tasks such as sentiment analysis. And finally, I just think they're really cool!

- *Irulan Murphy, MPhil Candidate*

# Stereotypes

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In one of my maths classes back in year 8, we were learning about the golden ratio; the teacher asked the class who knew what it was, and without much time passing turned to me and said I should know what it is. Before I could even process what he meant by that, I heard someone whisper “of course, she would know what it is.” This was one of the first instances where I noticed that people had an expectation of me because I was Asian. Being one of two Asian people in a class of 30, you notice inconsistencies in how teachers treat you versus your classmates. This is one of the first times I noticed an instance of stereotyping for being Asian.

I have always had two minds about stereotypes: that it is crazy to generalise everyone, and that they come from a kernel of truth. Stereotypes have been around as long as humans noted differences between each other. It is in human nature to try and put people into neat and tidy boxes. This helps people to systematise and organise information. You like coffee, I like coffee, so you are my type of person. However, doing this type of simplification to a person down to a couple of facts is just reductive. However, on the flip side, these are stereotypes for a reason. The generalisation has come from specific people’s cultural and social views of other people’s society and cultures. Whether that perception is good or bad is another thing.

This idea of “Asians are good at maths.” has come up again and again through out my life. At the end of year 9, I was moving to a new school that focused on maths and science specifically. I

was excited to move to a new place and told my then friends so, but sadly was confronted with “obviously you’d go that school.” It instantly dampened my excitement and didn’t talk about it until I left at the end of the year.

As I continued through my education here, this stereotype had started eating at my brain, especially when I needed to decide on what degree I was going to do. Part of me hated the idea of doing maths because I would be the stereotype, the another part was that it was something that I enjoyed doing. My main dislike came from the fact that I would fit into this nice little box that people have put me in throughout my life.

It may sound ridiculous, but it was a genuine conversation I had to have with myself at one point. Recognising that I shouldn’t stop myself because of a label that other people give me.

At the end of the day, being good at maths is one of the multitude of things that makes me as a person. This realisation led me to graduate with a maths degree and now continuing into a Ph.D. However, one point I would like to make in this rambling is that the stereotype “Asians are good at maths” falls short.

Currently, approximately 1/10 th of HDR students in maths are asian, and a hair better when looking at the staff numbers (Interestingly, the figure are a bit better gender-wise, approximately a quarter). We actually need more asian representation in the Maths discipline.

- Saranzaya Magsarjav, PhD Candidate

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