Adrian W. Dudek

3MT: A Fine Time to Find Primes

Thesis Title: *Consequences of numerical verification of the Riemann hypothesis to large heights*

We all have a shared history; when we were in primary school, our teachers told us that a number is prime if it's only divisible by one and itself. We might also share severe scarring, from when we popped our little hand in the air and asked the question: *primes - what are they good for?*

Well, if you're like me, you probably spend a bit of time stalking people on Facebook and checking online banking to see just how much money you don't have. Now the only reason we can do all of this without some hacker stealing our 90c, is because there's some hardcore security running in the background. And would you believe - this security is built on the observation that the primes seem to just pop up randomly.

We can see this by drawing a staircase over the counting numbers with a step at each prime. Random, right? But what happens if we zoom out to a much larger scale? Well, we notice that on average, our staircase actually looks well behaved.

This interplay, chaos and order meeting up for a cup of tea, is mesmerising, but it needs to be watched. If a hacker could precisely model the order within the primes, we could lose the very randomness that keeps us safe in the online world.

I'm not so concerned with security - I only have 90c. I'm interested because I think the primes are gorgeous. And it's not just me; mathematicians have been fascinated with the prime numbers for thousands of years.

My PhD research allows me to probe these tenacious little buggers. Primes, not mathematicians!

Well firstly, what do we already know about primes? Here are a just a few of my most favourite facts:

- One: the primes go on forever.

- Two: there are infinitely many primes that contain the number for Dominoes pizza in their digits.

- And three: a fact called Chebyshev's Theorem, which says that if you are at any point on the staircase, and you walk a certain distance, then you are guaranteed to find a prime (or step).

My research improves this result by reducing the distance you have to walk and showing that the primes are closer than we once thought.

How did I do this? Mostly just using the algebra I learnt in high school, but in a new freaky way. And of course, if it got too messy, then I would kindly ask computer for help.

But the score is actually [Adrian 1, Primes 1 000 000] because there is still so much that we don't know. And my research is important because Australia is a really young player in this area. So my next step is to head overseas and work with some world experts, so that I can bring this subject to life for future mathematicians here.

And for those among us with more than 90c, I can happily confirm that our knowledge is not even close to breaking down online security.

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