SMS Student Profile

Jordan Mitchell Barrett

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Quick details

Name: Jordan Mitchell Barrett

City of origin: Wellington

Programme of study: BSc, major Mathematics, minor Physics, 2017–2019
BSc(Hons) in Mathematics, 2020

What drew you to your programme of study?

Although I was good at it, I did not enjoy maths at school, so I originally came to VUW to study Physics and Computer Science. Of course, both of them require core math courses (142, 151, 161) in first year. Quickly, I found that the required math courses were more interesting than the physics/compsci courses I was taking! I switched to a math major at the end of first year.

MATH 161 was probably *the* course that made me switch to a math major. It really opened my eyes to a whole new side of mathematics which you don't see at school (namely discrete mathematics, logic and graph theory). Plus, it was the first time that mathematics was presented to me as an abstract exploration of structures and patterns (how pure mathematicians view it), rather than a sequence of computations and rules to memorise (how it is taught at school). I highly recommend MATH 161 to any student with any interest in mathematics.

After completing my BSc in 2019, my mathematical curiosity was still not satiated, so it was a no-brainer to begin an Honours degree. This has allowed me to delve much deeper into topics of interest (mainly logic), which were only covered superficially in undergrad, as well as round out my mathematical knowledge. At Honours, the courses are much smaller ($\sim$5 students vs $\sim$30 for undergrad), and you have much better chances to interact one-on-one with the lecturers and soak up some of their genius.

What did your coursework/research explore?

Coursework

My academic interests are in mathematical logic, which is a relatively new field of mathematics, with strong connections to philosophy and computer science. Logic deals with metamathematical questions, such as "what does it mean for a statement to be true/false?", "what is a mathematical proof?", "what does it mean to calculate something?", etc. These questions are answered respectively by the subfields of model theory, proof theory, and computability. Set theory is the other major field of logic, which deals with notions of infinity and possible foundations for all of mathematics.

My first exposure to logic was through the courses MATH 335 and MATH 309 (and we saw the basics of propositional logic in MATH 161). Those three courses are probably the favourite ones I took in undergrad, as they all introduce you to fascinating parts of mathematics that are totally unlike anything else you will encounter. VUW actually has one of the strongest mathematical logic groups in the world, especially in the subfield of computability. If you like the sound of logic, then this is the place to be in NZ!

Research

I have been involved in mathematical research at VUW through the Summer Research Scholars programme. I was fortunate enough to receive a Summer Research Scholarship in 2018/19, after my second year of study. I worked with Martino Lupini on a problem in combinatorics & Ramsey theory—partition regularity of Diophantine equations.

Essentially, for each natural number $(1, 2, 3, \ldots)$, you assign it a colour, and then attempt to find a solution to some equation, using only numbers of the same colour. An equation is called partition regular if you can always find such a solution, no matter how you colour the numbers! For example, we know that the equation $x + y = z$ is partition regular, but the equation $x + y = 3z$ is not (in fact, we can tell for every linear equation). A famous open problem in this field is whether the Pythagorean equation $x^2 + y^2 = z^2$ is partition regular—no-one has worked it out yet! The best we know is that it is partition regular when you only have 2 colours—this required a monstrous computer-assisted proof, taking 4 CPU-years of computation and generating a 200 TB file!

Martino and I used some tools from nonstandard analysis, a branch of logic, to prove certain equations were *not* partition regular. Along with a collaborator (Joel Moreira), we used tools from topological dynamics and ergodic theory to prove certain equations *were* partition regular. This project culminated in a paper co-authored by Martino, Joel and myself.

All students at VUW should definitely consider and make the most of the unique Summer Research programme we have here—to my knowledge, only UoA offers a comparable opportunity to its students. It's an invaluable chance to connect with leading academics in your field, get a taste of academic life, learn about your subject beyond what undergrad courses can teach you, and really find out if it is for you. Plus, how often is it that you get to co-author a journal article as an undergrad :)

Mathematical research is really the polar opposite of, say, a maths exam—instead of having some (hopefully not too hard!) problems to do under time pressure, you have significantly harder problems to solve, but unlimited time in which to do it. Some mathematical problems require hundreds of years and many, many great minds to solve (e.g. Fermat's last theorem). And even worse, in mathematics, there are problems which are impossible to solve, and we don't know which ones they are! (This is Gödel's incompleteness theorem—a very famous, early result in mathematical logic). You have to be careful not to waste time on a hard problem, and know when to cut your losses, as you could spend years on it making no progress.

When I was doing summer research, I would start by playing with examples to see what works and what doesn't. For the ones that work, you want to try and find their common features, and hopefully extract these into a general argument. Mathematical research follows you around, and can be hard to escape because your laboratory is in your head! Whereas if you're doing lab sciences, you can leave the lab at the end of the day and go enjoy your evening. You have to love math, and you have to learn to manage your brain time and focus on other things.

In the summer of 2019/20 (after completion of my BSc), I took up another summer research position with Martino. We focused our attention on different problems in Ramsey theory, still using the tools of nonstandard analysis. We found that many statements in Ramsey theory had the same basic structure, and could be proved by very similar methods. (For the mathematically inclined, the "structure" in question is that of a semigroup, split into infinitely many layers). We were able to extract a common generalisation, i.e. a result which reduces to many of these theorems when put in the right context. Currently, Martino and I are working on writing this up for publication.

I've also been involved in mathematical research via my Honours project, under the supervision of Rod Downey and Noam Greenberg. The project is in a field of logic called reverse mathematics. Usually, when doing mathematics, we start with a collection of axioms (statements which are obviously true), and then try and prove theorems using these axioms. Reverse mathematics does this in "reverse": we look at a mathematical statement, and try to work out which axioms are needed to prove the statement. I am studying the reverse mathematics of a statement called Cousin's lemma, for various classes of functions.

Extracurricular activities

In second and third year, I was the president of Vic Uke, the local ukulele club. We are a casual music club with a focus on enthusiasm, happiness and stage presence when performing, rather than perfectionism. Vic Uke was founded by a friend of mine from high school. I joined in my first year, and quickly got involved in running the club behind the scenes. For me, it appealed as a music club for non-musicians (that said, we do have some virtuoso ukuleleists in the club), and I've enjoyed having the opportunity to teach people from all walks of life about how to enjoy musical performance. I'm still involved in a lesser capacity.

Supervisors

My supervisors were: Martino Lupini for both Summer Research Scholarships, and Rod Downey & Noam Greenberg for my Honours project. In general, mathematicians seem to be very easygoing, and I've found Martino, Rod and Noam to be no exception. (Not to say that the work hasn't been hard, and intellectually stimulating!) They are always happy to discuss ideas, and I've appreciated the chance to draw on their knowledge and experience (though I often feel like I haven't even scratched the surface of their genius).

Did the programme/University live up to your expectations?

I'm not sure I had any expectations coming in—I mainly came to VUW because I was offered a good scholarship here. But I've found VUW to be a very good place to study mathematics. The academic staff are very passionate about what they do, and about passing that knowledge on to the students. Wellington is really a nice city to live in—it's small enough that you get to know people, and it's easy to get around, yet large enough that you don't get bored. There are always things to do!

What would you like to do in the future once you have completed your studies?

Once I finish my Honours, I plan to begin a PhD in mathematical logic in 2021. I will probably study in the US, but I have not decided yet. I'm undecided on the specific field too, but the areas of logic that appeal most are categorical logic (incl. homotopy type theory), model theory, and reverse mathematics. After the PhD, I aim to get a research/lecturing position in mathematics, and hopefully start a long and illustrious career as a logician.

Anything else you would like to add?

Tutoring

I first got involved in tutoring/marking as a second-year, marking assignments for STAT 193. (Marking assignments is not really that fun). Since then, I have tutored/marked for a variety of courses—STAT 193, ENGR 121, MATH 151, 161, and 309. This has been an awesome opportunity to develop my mathematical communication skills, and add some valuable experience to the CV for future academic jobs (and earn money, of course). It's really rewarding when you're able to help a student make sense of something which previously confused them.

Seminars

On the topic of communication skills, the school has a variety of seminars (Logic Seminar, Honours Seminar, Graduate Seminar) which senior students can get involved in. I have had the chance to speak at a few of these, and they've been instrumental in allowing me to develop my public speaking skills. Seminar talks require you to communicate complex, specialist ideas to a general audience within a short time period, which is a really useful skill to have in many situations.