

A UROP perspective by Archibald Browne

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UROP title: Formalising Mathematics Questions About the Integers

In the second year of my undergraduate degree at Imperial I was thinking forward to my summer prospects. I wanted to use my time to gain some technical skills outside of my course. So, in early October I began the hunt for a summer internship, sending out my CV and cover letter everywhere I could think of. By December I wasn't really getting anywhere, I had a few final round interviews, but they didn't amount to anything. This was about the time when my department encouraged us to apply for UROPs. I thought that my lack of success with applying to internships could be to do with a lack of experience, and this seemed like a great way to gain that experience whilst also studying something I really enjoyed. I contacted a few members of staff with my mathematical interests and within a few weeks I had an agreed UROP. Not all members of staff replied to my emails but those that did were really kind, and sometimes even pointed me to other staff members to contact. I also know some of my friends had interviews for their UROP but this was not the case for mine

As mentioned, initially one of my motivations for undertaking a UROP was to gain some valuable CV-worthy experience. However, it soon became clear that there was a plethora of additional benefits to pursuing the research. Even though I was only early on in my bachelor's degree, I was thinking about the decision of whether to do a PhD or not. The project involved a lot of independent time and so gave me a real taste of what it is like to motivate myself and conduct research when there are no strict deadlines. This is surely a key part of a PhD, so it was great to get a taste for that style of working to inform my decision. I also valued this opportunity in particular because of its focus on computer science. In Mathematics we learn a lot of theory, but I think that being able to code is really valuable for many of the careers we may want to pursue. It was great to get experience in open-source contribution and learning other important programming principles.

The research was focused around 'Lean', a functional, dependently typed programming language originally used for software verification but now commonly used as an interactive theorem prover by Mathematicians. I had a working knowledge of the language before the project through exposure to it in my first year but had to do a little extra reading before I was ready to make meaningful contributions to the research. My supervisor helped with this by directing me towards some useful resources.

I learnt a great deal over the course of the project, both technically and in terms of research skills. Of course, I have improved my skills in the Lean programming language, but I have also learnt about some computer science fundamentals like type theory and formalisation. More importantly, I have learnt what it is like to conduct research when you oversee your own schedule. It is not easy, and it requires a lot of confidence and determination to achieve all that you have set out for yourself on a given day. For the same reasons, it can also be incredibly rewarding and satisfying when you have a breakthrough or learn something new: you know that you were largely responsible for those results. It's a great feeling and I would encourage people to give it a go as I have learnt so much about myself and how I work best, skills that will no doubt be useful in any avenue I pursue in the future.

The experience has certainly influenced the rest of my degree. In my third year, I have agreed to conduct another research project as one of my elective modules with my supervisor. I am also going to be choosing other elective modules related to the field which I am really excited to begin. In terms of my future career, I think the project has given me several transferable skills relevant for any career, and a few technical skills that would really help me in career relate to programming/software/computer science. Overall, I am really glad I undertook the project and can't wait to see where my choice will take me.