Dyson - draft #3.1

Main Personal Statement

Most of what I do inside and outside of school is centred on my love of Mathematics. Because of this, I want to read Mathematics at University.

I do Maths, Further Maths, and Computer Science A Levels, which were all chosen to further my educational career in mathematics. I did the UKMT Senior Challenge and got Gold and Best in School. I am doing the MAT and TMUA at the end of 2022, and STEP in mid-2023. My Computer Science coursework is focussed on visualizing mathematics for the benefit of teaching. When I was learning linear transformations in school, I struggled to visualize them and I know a lot of my peers also struggled, so I wanted a tool that would show a given transformation and allow you to interact with it. I watched the 3blue1brown linear algebra series and wanted an interactive app inspired by it, but I could not find any that did everything I wanted. I mainly wanted to see matrix multiplication as transformation composition. Since I could not find a good app, I made one myself. In the course of this development, I faced many mathematical challenges around converting between

coordinate systems and drawing lines on the canvas. It has involved solving many small but interesting geometric problems. The project has also proved useful for explaining matrices to my peers, and for investigating questions involving 2D transformations. I attended the Imperial College London Further mA*ths Year 12 MOOC, which gave me a better understanding of topics including Maclaurin series, de Moivre's theorem, and hyperbolic functions. I will be doing their Year 13 course. I have found questions in textbooks that have prompted me to write my own LaTeX papers to explore the ideas these questions present. For example, there was a question that asked how many regions can be formed by dividing the plane with n lines. I enjoyed solving the question, and then created a paper using TikZ to draw circles split into regions. Another example is the question that asked for polynomials which give pure powers of n when summed from 1 to n. While exploring this problem, I found an interesting pattern in the coefficients that looked like those of binomial expansions. I explored this pattern and found a formula. My proof of this formula was originally several pages long but I then asked StackExchange about my discovery and learned that it was a finite telescoping series. This made the proof far shorter, and I learned a valuable lesson about stepping back to see simpler solutions, and collaborating with other people. I listened to A Brief History of Mathematics on BBC Sounds. My favourite episode was

about Galois. It detailed his life and inspired me to look further into Galois Theory. I found two YouTube videos from Aleph 0 on the topic. The topic is obviously beyond me right now, but I think I have got a grasp of the basics, and I definitely want to learn more. Abstract algebras like Galois Theory, Group Theory, and the dual numbers are interesting to me. It is these kind of abstract (and often fundamental) algebras that interest me the most. Early in Year 12, I joined an MIT MOOC about using matrices and their eigenstuffs to solve linear differential equations. I did not know what differential equations were, and I barely understood matrices, but I wanted to do the course. It started slow with linear transformations, matrices and their relationship and then introduced eigenstuffs. It was a great introduction and taught me a lot about the subject. My main lessons were row echelon form and Gauss-Jordan elimination, which allowed me to easily solve linear simultaneous equations by hand. I supplemented it with the 3blue1brown linear algebra series. But when the course started to talk about using these techniques to solve differential equations, I had to stop because I knew nothing about the subject. I tried to learn the topic with another MIT course, but this was over my head. I did not have the knowledge for it at the time, but I went back to it later and understood it much better. I learned that stepping away from a topic and coming back later can be greatly beneficial.

SAQ Personal Statement

I watched Welch Labs' series on complex numbers, which has a great visualization of multifunctions and 4D Riemann Surfaces. I first watched this series before I had learned about complex numbers in school and only understood the first half of it. I have since rewatched the series and I still do not understand all of it, but I have watched enough of Cliff Stoll talking about Klein Bottles to understand a fake intersection caused by projecting 4D into 3D. The series is fantastic at communicating complex ideas in a visual way, and has greatly increased my understanding of complex numbers, along with other online learning resources. Episode 2 of The Numberphile podcast is an interview with Ken Ribet about Fermat's Last Theorem. This episode is very interesting and gives a good overview of the story and touches on Wiles' proof. However, I wanted to investigate further. I watched some YouTube videos about elliptic curves and modular forms and got a very surface-level overview of the topic. Upon further research, I continued to learn more about it. I still do not understand it in much detail, but I get the gist and I love the connections between number theory and complex analysis. Connecting seemingly disconnected areas of mathematics like this is something I love, just like how

I connected polynomials that sum to pure powers with coefficients of binomial expansions. In Further Statistics, we have to calculate probabilities that require storing numbers in distribution mode and doing things with them in normal mode. To fix this inconvenience, I created a Python package called probcalc that allows you to calculate arbitrary probabilities with various distributions. It is installable with modern Python versions, so I can use it on my phone. Episode 6 of The Numberphile Podcast is an interview with David Eisenbud about his life and the MSRI. This episode taught me what being a mathematician is actually like, and made me want to become a mathematician and spend the rest of my life doing research mathematics.

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