Experiences. I have always enjoyed math, but it wasn't until I took an introduction to proofs class in high school that I learned how beautiful math could be. In particular, I was completely captivated by Euler's proof that $\sum_{n=1}^{\infty} n^{-2} = \frac{\pi^2}{6}$, and this ultimately inspired me to pursue math in college.

I entered the University of Miami (UM) as a Foote Fellow, which absolved me of all general education requirements. Because of this I was able to take a wide selection of math and computer science courses at UM. While I enjoyed almost all of my classes, the one which stood out the most was the graduate course in hyperplane arrangements taught by Richard Stanley. This was my first course in combinatorics, and at the time it was the hardest math course I had ever taken. Most problems took well over an hour to solve, and the thrill of solving a problem that had stumped me for days was exhilarating. This course is what initially made me interested in studying combinatorics at a deeper level.

My interest in combinatorics was further strengthened by attending the Budapest Semesters in Mathematics (BSM) program. In addition to being an excellent cultural and social experience, the BSM program allowed me to take a number of courses that I wouldn't have been able to take at UM, such as courses in hypergraph theory and extremal graph theory. At BSM I took part in my first ever research project under the guidance of Attila Sali. The process of performing mathematical research was probably the hardest, most stressful, and most rewarding things I had ever done, and this experience greatly confirmed to me that research in mathematics was something that I wanted to pursue. This program deeply shaped my mathematical interests, and in particular it made me very interested in Hungarian style combinatorics, such as graph theory and extremal combinatorics.

During the summer of my senior year I attended the University of Chicago REU program. Through this program I studied and wrote an expository paper on the Fourier analysis of Boolean functions, which is a powerful tool used in theoretical computer science that has a very combinatorial flavor to it. The research and writing for the paper was mostly done independently, though I did have regular meetings with a graduate student mentor to help me better understand the material. Through the program I became better at reading and writing mathematics, but perhaps the greatest benefit of the program was the social aspect. This REU was the first time I had ever met so many people my own age who were as interested in mathematics as I was, and I absolutely loved the sense of mathematical comradery that we shared. To a large extent, the interactions with my peers at this REU solidified my desire to continue to study mathematics in graduate school.

I have been fortunate to have had many opportunities to be exposed to a wide variety of mathematics. As an undergraduate, I attended a two week mini-course in algebraic geometry taught by Christopher Hacon, with the course starting from basic ring theory and ending with sheaves. As a graduate student, the courses I took in preparation for my qualification exams have given me a solid foundation in areas such as real analysis, representation theory, and algebraic topology. Because of the enjoyment I have gotten out of expanding my breadth of mathematical knowledge, I have made it a point to try and regularly read texts outside of my area of specialty, such as texts in Galois Theory, Complex Analysis, and Model Theory.

Research. I have had several opportunities to take part in mathematical research, with each project presenting its own unique set of challenges and sharpening my skills as a mathematician in a new way.

The first research project I took part in was through the BSM program under the supervision of Attila Sali. The project was in the area of Forbidden Configurations, which deals with certain problems in extremal hypergraph theory. The work was mostly done independently, though Attila did provide some key proofs and a lot of guidance as to which problems should be tackled next. This project continued throughout the semester, eventually ending with us publishing a paper where we determined the order of magnitude of our relevant extremal function for essentially all of the hypergraphs that we had wished to find. We even managed to prove some exact results, which are fairly rare in this field. Our paper was published in 2017 in the Electronic Journal of Combinatorics.

After providing a novel solution to a homework problem related to spectral graph theory, Richard Stanley asked me to investigate whether or not my solution could be generalized further. This ultimately led me to publish a paper where I proved the following: the only connected graphs satisfying $A^r = f(L)$, where A is the adjacency matrix, L is the Laplacian matrix, r is an integer, and f is a polynomial; are graphs which are regular or biregular, which is a rather curious characterization of such graphs. Richard was mostly hands-off during this project, which allowed me to get a better sense of what it's like to do mathematics independently, and this also made me better at figuring out how to ask good questions. This project helped me establish a solid foundation in spectral graph theory, which has helped immensely in the research projects I am currently pursuing. This paper was published in 2018 in the Journal of Graph Theory.

After entering graduate school at the University of California at San Diego (UCSD), I started doing research with Jacques Verstraete and Fan Chung. The research with Jacques has mostly been centered around various problems of extremal combinatorics, ranging from classical areas like Ramsey Theory to more recent areas such as Saturation Games. Most of this work has been done independently, but Jacques' guidance on how to approach problems has been invaluable. In particular, every time I prove a bound, Jacques is always quick to ask whether this bound can be sharpened further. This has not only led to me proving much stronger results, but it has also taught me the value of pushing one's results as far as they can go.

The research I've done with Fan Chung has covered many areas of combinatorics, with most problems being related to spectral graph theory. One particular project we worked on was a problem of David Callan's. Callan conjectured that the number of permutations in S_n which can be written as the product of odd cycles is also the number of permutations in S_n whose up-down signature have non-negative partial sums. While working on this problem, I conjectured that a stronger version of Callan's conjecture was true. I then went on to prove several special cases of this stronger conjecture, which involved finding neat formulas related to Eulerian numbers and Eulerian-Catalan numbers. This stronger conjecture also led me to development a new permutation statistic, which could be of independent interest.

Recently I have had the opportunity to work on a joint project with my classmate Daniël Kroes (under the supervision of Fan Chung) involving certain kinds of random graphs. The graphs we are investigating (paperclip graphs) have only been considered recently, and as of now no one has considered random versions of such graphs. Because of this, the two of us have had to develop most of our theory from scratch, both in terms of how such graphs should be randomly generated, as well as the methods used to prove results about these graphs. This has made the project very challenging at times, but also very enjoyable. This is the first project I've worked on where my collaborator was a peer instead of an advisor, which has made this project much more collaborative than any of my previous projects. Our different strengths complement each other quite well, and whenever one of us runs out of ideas, the other is able to come up with a new direction to pursue. It has been a pleasure to work with Daniël on this project, and I hope to be able to work on more joint projects with him and the rest of my peers in the coming years.

Broader Impact. I love the mathematical community, and I do my best to be involved with and strengthen this community as much as possible. With the assistance of my undergraduate advisor Drew Armstrong, I founded and served as the president of UM's math club for two years. This club provided a place for the math majors at UM to come together socially to discuss and learn more mathematics. As President I helped organize most of our meetings. Some meetings involved students or professors giving talks about interesting mathematical ideas, while other meetings involved playing mathematical games such as math bingo. I learned a lot about leadership by running this organization, and I hope that the club continues to prosper and strengthen the mathematical community at UM for years to come.

As a graduate student I have continued in my efforts to try and bring my local mathematical community together as much as possible. I've started two seminars at UCSD: one on spectral graph theory, and the other a general graduate student combinatorics seminar (co-organized with Jason O'Neill). I am a member of our graduate student council, which works to improve the graduate student experience at UCSD.

I have organized several social events for the graduate students at UCSD. One of my favorite events that I get to organize is "Banach Barski" (co-organized with Eric Lybrand), which is a weekly get together at a nearby bar that is open to all graduate students at UCSD. I do my best to get as many people as possible to come each week, and it's always a joy to see new connections being made at these events.

I am always happy to share my work with others at conferences and seminars. I've given talks at the Joint Mathematics Meetings, the BSM 100/3 reunion conference, the graduate student seminars at both UM and UCSD, and several others. One such conference was the Graduate Student Combinatorics Conference (GSCC), which is a conference run by graduate students for graduate students. I successfully petitioned to have UCSD host GSCC in 2020, and I am now serving as one of the main organizers for this conference. Some of my duties for this include establishing a budget, organizing the facilities that we will use, writing grant proposals, recruiting speakers to give plenary talks, and making sure that the conference participants get properly reimbursed. I hope to make GSCC 2020 a memorable conference for all that attend!

Goals. My main career goal is to become a professor of mathematics at a research university. This path will allow me to continue to learn more mathematics, solve hard problems, contribute to the growing pool of mathematical knowledge, interact with the mathematical community that I enjoy so much, as well as to demonstrate and instill the beauty of mathematics into my students.

An NSF GRFP fellowship would allow me to spend more of my time at graduate school focused on contributing to the field and to the mathematical community in general. In particular, such a fellowship would allow me to dedicate more time to making sure that GSCC 2020 is the highest quality conference that it can be.