# Personal Statement

Matias Relyea

My name is Matias Relyea, and I am a freshman at the University of North Carolina at Chapel Hill pursuing a B.S. in Mathematics. I am applying to OSUIM because I believe it is the optimal next step in my pursuit of graduate study in mathematics. Sometimes I ask myself: why do I like math? Is it the research that I've done, or the papers that I wrote? Was it working with other people? It was certainly all of these, but the first time that I truly realized that math was what I wanted to do was when I took a January term mini-course on surreal numbers in 2024. At the time, I had already been enthralled by number theory, having done quite a bit of number theory reading through lecture notes. Surreal numbers, however, opened a new door to John Conway's *On Numbers and Games*, and I couldn't get enough of its whimsy and uselessness. A YouTube video by Owen Maitzen on Hackenbush was just so entertaining, and this inspired me to work on omnific integers, a number-theoretic connection with surreal numbers that Conway had minimally mentioned in his book. I gave a short presentation on integer clouds and some new combinatorial observations regarding omnific integers; this was the entirety of the January term, but I managed to get my hands on a mini copy of Donald Knuth's *Surreal Numbers* and I look back fondly on the experience.

This experience got me more into research. My background is largely in number theory, though, like the January term on surreal numbers, I have developed interests in combinatorics and algebra. My first introduction to formal math and research was the Independent Research and Paper Writing class at Euler Circle in the summer of 2022, where I wrote a 44-page paper on quadratic reciprocity and its applications. I presented a 15-minute talk at its conclusion. While most of my investigations were in elementary number theory, mostly pertaining to Eisenstein's lattice-counting proof of the famous result, my paper also covered quadratic Gauss sums, beginning a close interest in algebraic number theory and higher reciprocity in the following years.

I developed this interest by reading Rosen and Ireland's *A Classical Introduction to Modern Number Theory* under the guidance of Professor Tamar Avineri, who taught an illuminating elementary number theory course at the North Carolina School of Science and Mathematics. Professor Avineri's mentorship culminated in two papers, with *The Quadratic and Cubic Characters of 2* being published in *Mathematics Magazine* (2026). One particular aspect that excited me about working on this paper was being able to learn about the history of mathematics (as I experienced thoroughly through Lemmermeyer's *Reciprocity Laws: From Euler to Eisenstein*), and solving small problems that I had never even thought to consider on the way. Unfortunately, Professor Avineri passed away in May of 2025, though her impact on my approach to exposition and research was undoubtedly immense.

I also collaborated with two classmates on an original research project concerning polyomino placement in colorings of square and triangular grids during the following January term. This experience allowed me to get a taste of research mathematics in a fast-paced collaborative setting that demanded constant original contribution. Working intensively over two weeks resulted in a paper that was ultimately accepted to the NCSSM scientific journal, *Broad Street Scientific*. Both of these papers culminated in presentations at the NCSSM Research Symposium in 2024 and 2025.

At UNC, I have pursued coursework in analysis and advanced linear algebra, served as an undergraduate learning assistant for a discrete mathematics course, and completed a directed reading program on Tom Leinster's *Basic Category Theory*. Adjusting to advanced proof-based coursework presented challenges in my first semester at UNC, but this experience has strengthened my mathematical maturity and approach to problem-solving. In the spring, I am taking topology, algebraic geometry, and algebraic structures. I am also preparing two one-hour talks on the contents of my paper published in *Mathematics Magazine* for presentation to the university math club. Altogether, my DRP in category theory, work in algebraic number theory, and upcoming spring coursework prepare me well to approach a project at OSUIM.

At OSUIM, I'm particularly drawn to projects relating to algebra, combinatorics, category theory, and number theory. My work on reciprocity laws and algebraic number theory topics such as Gauss sums and number fields prepares me to tackle many potential number theory projects, and after reading chapter 1 and bits of chapter 2 from David A. Cox's *Primes of the form* $x^2 + ny^2$, I became quite interested in class field theory and more pertaining to finite field theory, areas that I am eager to progress in and contribute to. I am also interested in how my prior work may connect to category theory and combinatorics. Altogether, participating in OSUIM represents the perfect opportunity to develop as a mathematician and be excited by making progress on interesting mathematics, just like surreal numbers did for me.