During the first year of my PhD program, I have written and submitted a research paper, presented this work at my alma mater, and made progress on a second project, all while excelling in coursework and teaching. Throughout the rest of my PhD, I plan to synthesize game theory, discrete optimization, and computational geometry/topology to tackle political districting problems and related applications. In the long-term, I aspire to become a professor in an environment where I can bridge theory and applications in my research and educate the next generation of leaders.

My interest in earning a PhD in Computer Science became clear to me in my junior year of undergrad, the culmination of over a decade of self-discovery. Through math competitions in elementary and middle school, I fell in love with the science and art of problem-solving. In high school, a friend and I self-studied computer programming and founded our school's computer programming team, competing (and placing) in tournaments hosted by the University of Central Florida and the University of Florida. Through the programming team, I discovered the joy of implementing mathematical ideas and structures in programming to solve complex problems.

After graduating from high school as a National Merit Scholar and salutatorian in a class of 560, I continued to excel in my undergraduate years, pursuing a double major in Computer Engineering and Mathematics with a minor in Computer Science at Rose-Hulman Institute of Technology (RHIT). With an emphasis on connecting theory to applications and a collaborative, family-like environment, RHIT proved an ideal fit for me. In my early years at RHIT, I most enjoyed my courses in discrete math, data structures, and algorithms. I maintained a 4.0 GPA despite the rigorous coursework of a double major compressed into three and one-third academic years, one of six in my graduating class of over 500 to do so.

The following year, my success in our algorithm design and analysis course earned me an invitation to an independent study with my professor, Nathan Chenette. My project was to design and implement a solution to a laboratory group assignment problem for our Chemical Engineering department. In this project, my initial genetic algorithm approach proved unsuccessful, providing an opportunity to grow in perseverance, an essential virtue for researchers. Through continued literature review and brainstorming sessions with Prof. Chenette, **I devised a solution that reformulated the assignment process as a sequence of maximum flow problems. My implementation efficiently solved the assignment problem** and allowed the user to adjust intermediate solutions. At the end of the project, I presented my work at the 2016 RHIT Undergraduate Mathematics Conference, gaining valuable experience communicating research ideas. Based on my achievements in courses, the independent study, and extracurricular activities, I earned the **Henry Turner Eddy Award in Applied Mathematics** and the Clarence C. Knipmeyer Award in Computer Engineering at the 2016 Rose-Hulman Honors and Awards Ceremony.

I gained further research experience in the summer of 2016 through a research-oriented internship with LGS Innovations, developing a generalized wireless communications link budget model for a defense application. My assigned mentor at LGS was at a different location across the country, allowing me to **grow as an independent researcher** in between our limited interactions. The project required me to survey techniques in recent literature and synthesize them in a practical implementation, a useful skill for my current research projects.

In parallel with my first research experiences, I honed my teaching skills at RHIT as a Learning Center tutor, helping underclassmen grasp foundational concepts in computer science, math, and physics. I also worked as a course assistant for the Computer Science and Software Engineering department, creating course materials and grading assignments for our Operating

Systems course. I was also a technical writing tutor, working with seniors and graduate students to refine their thesis papers. As technical writing is an oft-neglected aspect of STEM education, I am grateful for the writing training I received at RHIT and **plan to promote technical writing as a future professor**.

My undergraduate research experiences opened my eyes to the possibility of academic discovery outside of a textbook or lecture. Furthermore, my time as a peer tutor in the campus Learning Center and as a course assistant for the Computer Science department illuminated my affinity for helping others construct their understanding of math and computer science. These discoveries naturally led me to pursue a career as a professor of computer science and/or mathematics, uniting my passions for research and teaching.

In pursuit of this goal, I entered the Computer Science PhD program at the University of Illinois in the fall of 2017 with the help of the Saburo Muroga Endowed Fellowship. I quickly joined Sheldon Jacobson's Simulation and Optimization Laboratory, attracted by the group's unique blend of theory and applications. My decision was also motivated by my fundamental belief that **computer science can (and should) help us tackle societal concerns**. Within the United States in particular, there are numerous opportunities for algorithms and data-driven public policy decisions to promote justice and well-being. Our lab has previously contributed to society through breakthroughs in aviation security, immunization economics, and the relationship between transportation and obesity. In this tradition, I am building upon our work on political districting problems, aiming to **transform the redistricting process to promote transparent elections**. Our lab also **promotes public scientific literacy in predictive analytics** through interactive websites based on our research in election analytics and sports forecasting, which have attracted national media attention.

Continuing our work on political districting problems, I am generalizing a recent paper which takes a game-theoretic approach. I am also extending the geo-graph model, a tool which accelerates district contiguity checks during local search algorithms. In both research directions, I have proven some initial results (not yet published) and continue to work toward more extensive generalizations. My research statement expounds on these projects and details my progress to date. I have also contributed to our group's ongoing work in sports analytics, developing new models for predicting the NCAA Division I men's basketball tournament and evaluating the models through computational experiments. From this work, I submitted a first-author paper [1] which is under review and presented at the RHIT Mathematics Colloquium. I am currently supporting a master's student in our lab whose thesis work builds upon my results.

Alongside my research work, I served as a Teaching Assistant (TA) for Discrete Structures in my first two semesters at the University of Illinois, facilitating two discussion sections for 30-45 students and occasionally giving lectures or review sessions for the 300+ students in the course. In both semesters, **I earned a place on the university's List of Teachers Ranked as Excellent** based on student evaluations. Striving to become a more effective teacher, I joined an interdisciplinary TA reading group of *What the Best College Teachers Do* by Ken Bain, working toward a Graduate Teacher Certificate from the Center for Innovation in Teaching and Learning (CITL). These experiences broadened both the theory and practice of my teaching, and I will continue to seek such opportunities for professional development throughout my PhD program.

Service and Leadership: At RHIT, I volunteered as a proctor and grader for middle and high school mathematics competitions we hosted, advancing our mission to cultivate young minds as they begin to explore STEM fields. I also volunteered with Engineers Without Borders (EWB), working with a team of students and our technical and cultural advisers to "debug" a

septic system for a rural medical clinic in the Dominican Republic. Through our interactions with local community leaders, I learned two important lessons: **(1) creative problem solving spans cultural and socioeconomic boundaries, and (2) collaboration between groups with different perspectives can produce more robust solutions.** I firmly believe these principles apply to academic research as well.

In my first year at the University of Illinois, I helped prospective Computer Science PhD students learn about our department by serving as a Grad Ambassador. This year, I am part of a revived initiative in our department for older PhD students to mentor first-year students, helping with everything from understanding program requirements to learning about the Champaign-Urbana community. I also volunteered to co-lead the training session in August for new TAs in the Computer Science department, encouraging effective teaching methods to ensure our undergraduates are well-prepared to enter the workforce or pursue graduate studies. Grateful for the selfless support I have received from others, I strive to give back in these small ways.

Future Goals: After completing my PhD, I hope to become a faculty member at an undergraduate engineering institution, such as RHIT, where I can pursue my passion for teaching while advancing knowledge in theoretical computer science. I plan to give back to the community through activities which foster excitement and discovery in STEM fields for K-12 students, such as the math and programming competitions which fueled my journey. I will train the next generation of researchers in industry and academia, instilling students with a desire to serve society through impactful research projects and volunteering. Finally, I aspire to collaborate with researchers in other disciplines to advance theoretical computer science and operations research and tackle urgent problems in public health and well-being, national security, and national infrastructure.

Intellectual Merit: My strong academic record and undergraduate research experiences have prepared me to bring together fields ranging from algorithm design to game theory to solve practical problems in political districting and related applications. Within my first year of the PhD program, I developed a research project in sports forecasting into a submitted first-author paper and made progress on an interdisciplinary project in political districting. With several ideas for future extensions to the political districting work, I am poised to contribute both theoretical and practical results over the next several years.

Broader Impacts: I view my research in computer science as an opportunity to serve society. My current research project has the potential to increase transparency in the political redistricting process, addressing a pressing concern in the United States, and I will seek other beneficial applications of the theoretical advances made in this project. I also have a passion and aptitude for STEM education, and I believe my drive to constantly improve as a teacher will make me increasingly effective throughout my career as a professor. Finally, I appreciate those who have helped me become who I am, and I actively pay it forward by volunteering to help others adapt to graduate school and prepare for teaching responsibilities.

Conclusion: The NSF Graduate Research Fellowship Program would enable me to continue bridging the theoretical foundations and practical applications of computer science throughout the remainder of my PhD program. It would also afford me more flexibility in establishing my own research agenda and initiating collaboration across different research communities. In the long-term, this award would provide a springboard for my future contributions to society through applied research and effective teaching.

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[1] Ludden, I.G., Khatibi, A., King, D.M., and Jacobson, S.H. (2018). “Models for generating NCAA men’s basketball tournament bracket pools.” *Submitted*.