Research Statement

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I am a third-year mathematics major at the University of Illinois Urbana-Champaign. My research interests lie in the intersection of mathematics, algorithms, and computational complexity. My motivation for wanting to study these fields comes from the interconnectedness found in them. Bridging seemingly disparate problems and theorems often yields new insights. However, these connections can also be surprisingly organic, hinting at something more profound underlying the problem. I became interested in complexity after learning about various lower bound reductions in my fine-grained complexity course where many proofs make these types of connections between problems. My interest in mathematics comes from learning about the connection between fields and group theory via Galois Theory. My goal as a researcher is to combine various algorithmic design techniques such as reductions and graph modeling with analytic and algebraic tools in order to discover the connections between problems in algorithms and conditional complexity.

My current research is primarily algorithmic in nature. For instance, my prior work "Post-Disaster Repair Crew Assignment Optimization Using Minimum Latency" with Asst. Prof. Melkior Ornik, published at IEEE ISC2 2022, developed a heuristic algorithm for the multi-agent minimum weighted-latency problem. Currently, I am working on a problem of deception where the goal is to design a graph that minimizes the potential for adversarial agents to move in a deceptive manner. I hope to build on the skills and techniques I have developed in my research in order to work on both more abstract algorithmic as well as purely mathematical problems at Texas State.

My coursework supports my current and future research interests. I have taken a wide variety of mathematics courses ranging from probability and real analysis, to number theory and abstract algebra at the graduate level. I also have taken multiple courses in algorithms and complexity, including a fine-grained complexity course where I studied recent results in hardness and various conjectured and conditional lower bounds. The concepts in these courses have not only developed my understanding of prior work in both mathematics and computer science, but have also allowed me to be comfortable with abstract, formal reasoning.

My interests in math and computer science go beyond just learning and research. I have been a course assistant for many courses including introductory programming, discrete math, algorithms, and models of computation courses. My love for teaching also extends beyond just courses. I create cryptography meetings for my university's cybersecurity club in which I talked about various topics in number theory including the computational complexity of modular inverses. I also started a math and algorithms club where I made a number of meetings ranging from decidability to various ways to compute Fibonacci numbers. Teaching is a large part of why I love mathematics and I hope to learn more about how to become a more effective teacher and communicator of complicated ideas.

By being at Texas State, I hope to gain mentorship and connections in pure mathematics, especially with those working in more algebraic fields. The project on prime graphs with Thomas Keller is the one of most interest to me since not only will it build on concepts I have seen in prior algebra courses, such as Sylow's theorems and solvable groups, but also it will allow me to apply it to graph theory which would build on concepts I learned in my research. Having the opportunity to learn a system like GAP is also quite enticing since I have never worked with a fully mathematical programming framework. The project with chip firing games is also interesting since I have played with these games in some self study when talking with friends about research they were doing. Being able to work with professors who work in algebra and related fields is one of the largest reasons I want to be a part of this REU. I would be able to do pure mathematics research, which is quite different to my current research. This would allow me to help grow as a researcher both in mathematics and theoretical computer science. Thus, I will gain more clarity about the work I want to do in graduate school. By working with these

professors, I hope to raise the quality of my research and writing in order to make more meaningful contributions to the fields of theoretical computer science and mathematics. I will also see what full-time research is like by being able to fully focus on my research rather than having to work around my courses. I believe that the people, along with the work that they do, make Texas State the best place for me to grow as a researcher.

I believe that my background in both pure mathematics as well as theoretical computer science, along with deep rooted motivation to study problems in algorithms and complexity, would allow me to make a significant contribution to a research project at Texas State. In parallel, it would provide me with the technical and interpersonal skills in order to transition into graduate school. Thank you for your time and consideration for this exciting opportunity.