Personal Statement – Kristi Belcher

After four years on an all-girl high school engineering team and with the advice of my mom, who is a computer scientist herself, I decided to major in computer science with a minor in mathematics at Texas State University. In my first years as an undergraduate student, I enjoyed the intellectual challenge of my computer science courses. I liked the puzzles that I was given to solve in my assignments, and I liked working in teams on projects. There was a clear difference between these classes and my core classes, which were not as interesting and fun to me. As I was taking more courses, I kept previous concepts fresh in my mind by becoming a grader. I saw assignment problems, the professors' solutions, and common student mistakes while grading for Foundations of Computer Science I and II as well as Data Structures.

My curiosity in computer science grew throughout my first two years as an undergraduate, so I decided to apply for a Research Experiences for Undergraduates (REU) Program at the University of Texas at Dallas. While in the program, I was assigned the Privacy and Security Analysis of Social Networks research project. I was in a group of three other researchers, and I took the initiative to become the team leader for the duration of the program. We met with our adviser and several of his PhD students to determine the direction of the project and obtain guidance for how best to conduct our research. My team and I decided to focus on the reasons why users adopt social networks even though previous work had suggested users know that social networks lack adequate security of private information. We discovered, through interviewing and surveying different people, that there was a prominent psychological factor that was coming into play – Intrinsic Reinforcement. Through our work, we helped increase user awareness of privacy and security issues, created a model for further understanding, and laid the groundwork for future work to be done. I remember going home at the end of the day excited to tell my friends about my project and what I had learned. It was because of the REU program that I first became interested in the idea of going to graduate school.

After the REU program, I submitted my work to the Grace Hopper Celebration of Women in Computing conference. My research was accepted to be presented at the poster session. It was at the Grace Hopper conference that I discovered my passion for research. The combination of presenting my research, being exposed to other REU student presentations, and attending research presentations by other women solidified my decision to get involved in research even more. My first Grace Hopper experience inspired me to attend the conference ever since. Each year, I attended many workshops and saw firsthand the diverse research topics that other women had completed. Additionally, I presented my research at the Texas State University Undergraduate Research Fair and the Undergraduate Research Expo at the University of Texas at Dallas. At both events, I was able to share my work with others, its importance in advancing knowledge of privacy implications on social networks, and the impact that it had on users. It was the ultimate push to get more involved, but I did not know which area of computer science was right for me – yet.

Everything changed in spring 2015 when I took a Parallel Programming class. I discovered a whole new world – the world of High-Performance Computing. I was so enthralled by the material I was learning that, over spring break, I decided to parallelize the Traveling Salesman Problem with OpenMP on my own – my first encounter with using OpenMP. I was so excited when it worked

that I immediately emailed the professor to show him. He was so impressed by my enthusiasm for the subject that he offered me a spot in his research group as an Undergraduate Researcher. I jumped at the opportunity. As the semester went by, I knew I had made the right decision since my mind continued to be blown away as we learned about GPUs and CUDA. By the end of the semester, I knew that Parallel Computing was an area that I could do amazing research in, and the idea of a graduate education became a clear educational goal of mine.

In summer 2015, I had my first internship at ExxonMobil in web development and User Centered Design research. This internship gave me a taste of what industry is like. I worked with the Mobility and Design (MAD) team to develop a new website with a user centered approach. My work included conducting one-on-one user interviews, in which I asked about how they interact with the MAD team's current website. Next, I took what I learned from the users and concatenated it into an Affinity Diagram and drew conclusions for certain features and utilities that users needed from the site. Then, before I began the development work for the new website, I met with team members to discuss my findings and explain the needs and frustrations of users that had to be addressed. During my internship, I got a sense for working both in a team and on my own while reporting back to a mentor and supervisor. I definitely enjoyed my time at Exxon, but I realized that I had much more to learn after interacting with the professional developers and database programmers on the team. At this point, I knew I needed a graduate education to gain the expertise to excel.

In fall 2015 and spring 2016, I took an Undergraduate Research course at Texas State where I worked with my parallel programming professor to complete a research project on Multi-GPU Parallelization of Irregular Algorithms. After I took the Parallel Programming class, I discovered that I wanted to explore GPUs more in depth because they really excited me and I knew there was a lot more to learn in that area. During my year of research, I parallelized a Fractal, an N-Body, a Maximally Independent Set (MIS), and a Connected Components (CC) algorithm to work on multiple GPUs. We chose these algorithms to study the effects of varying amounts of irregularity on performance. I discovered that irregularity harshly affects performance on multiple GPUs, largely because of the needed communication between GPUs. For example, with the Fractal and N-Body codes, we obtained considerable speedups (1.78 or more), and the best workload distribution was about 50% and 50% on two GPUs. In contrast, the MIS and CC codes did not yield any speedup using multiple GPUs and preferred an uneven workload distribution. We discovered that memory access irregularity played a more significant role than control flow irregularity in the performance of multi-GPU irregular algorithms. To conclude the course, I presented my research findings to a group of people. At the end of the fall 2016 semester, I will be presenting this research again for my Honors Thesis, which I plan to submit to a conference or journal. Additionally, I went to the GPU Technology Conference (GTC) in April 2016, where I learned about emerging technology and got a chance to listen to more research presentations. I was greatly inspired by the possibilities in GPU research, which filled me with a desire to expand upon my own GPU research. My findings from the Undergraduate Research course lead to an Independent Study that I am currently working on where I study the effects of Peer-to-Peer (P2P) direct communication between GPUs. With P2P, the GPUs can exchange data directly instead of needing to go through the CPU, minimizing transfer time. I am hoping that using P2P communication will give better performance for both the

MIS and CC codes on multiple GPUs. I cannot wait to present this research at conferences like Grace Hopper or GTC. With the kind of success I have had as an undergraduate, I am overwhelmingly excited about the prospect of what I may be able to accomplish in graduate school.

In summer 2016, I had my second internship, this time at Qualcomm, where I worked on the Modem Performance team. The first part of my project involved working with the modem testing team in which I measured the performance of various modems to make sure that they met certain performance standards. I learned about the testing software and was able to accumulate "best practices" and "quick fix" tips from my experiences throughout the summer to share with the team. I also earned a Diamond Level "Qualstar," which is Qualcomm's highest internal award for excellent work while in the lab. The second part of my project was writing a program to analyze the raw memory of heap allocation dumps of the different modems to find where memory is potentially wasted. By calculating how many kilobytes of all zeros there were in the raw memory, I could locate suspicious heap allocations and determine what those allocations were used for. My team then used this program to improve the performance of the codes they use on the modems. I also volunteered to give an Ignite Speech about Parallel Computing to approximately 80 people during the Women's Summit at Qualcomm. I wanted to share what I knew and inspire others to be involved and learn more, too. I also volunteered to be a Q-camp mentor, where I talked to 8th grade girls about my experiences in STEM and encouraged them to try it themselves. I did such quality work at Qualcomm that I was offered a return internship for summer 2017.

Intellectual Merit

With my strong academic performance at Texas State University, a GPA of 3.94, and my many previous professional and research experiences, I have demonstrated diligence, determination, and dedication. I continually seek out opportunities that will increase my computer science knowledge by doing projects on my own time and participating in conferences. Moreover, because I have already made substantial contributions to High-Performance Computing research as an undergraduate student, I believe I will succeed in my graduate education as well.

Broader Impacts

One of the best things my parents did for me was enrolling me in an all-girl high school, St. Agnes Academy. It was here that I gained an appreciation of the notion that I could do anything if I put my mind to it. At St. Agnes, I realized that gender was not a limitation – it was an opportunity. I was given the courage and the motivation to achieve my goals, no matter how hard they may be. With that background, I excelled in computer science as an undergraduate, despite being one of the few women in my field. Therefore, I am dedicated to encouraging young girls and women to achieve their goals just as I have been. With my previous experience of mentoring girls, I will continue to do so through my graduate education, encouraging them to become involved in computer science and showing them the amazing opportunities available. I will also do outreach at conferences like Grace Hopper, where I can be an active role model for women, whether students or professionals, to continue to strive for greatness within computer science and STEM.