My research activities have included work in the fields of robotics, human computer interaction, data mining, and most recently and deeply, networking. This diversity of experience has given me the opportunity to approach research questions from many different directions and to cross-pollinate ideas between different fields of computer science. While my research interests have been varied in my undergraduate career, I have remained focused on two goals: developing the tools to be of service to both the research communities I've been a part of and to the world at large, and developing the skills to be an effective computer science researcher.

In the summer after my first year, I worked on a joint project between University of Tennessee – Knoxville and Oak Ridge National Lab, where I developed a vision-based tracking system for a mobile robot platform. I worked on my project in parallel with a graduate student developing a wireless sensor network to detect anomalous situations in an environment. Her sensor network would notify a mobile robot of the anomaly, and upon being dispatched to the location, the robot would identify and follow any intruders it detected as they moved about. My tracking software was able to identify a moving target and direct the mobile robot to follow it, operating in a challenging indoor environment with a variety of lighting conditions while remaining remarkably robust against false positives and noise.

Through my work on the tracking system, I was able to learn about the fields of computer vision and robotics as well as the current issues and open problems facing each field. With little knowledge of either of these fields at the beginning of my internship, I learned to independently seek out solutions to problems in published literature and to develop and test my own solutions. A key lesson from that summer was that progress in computer science research sometimes means backtracking from a local minimum solution. Midway through the summer, I determined that the color-based algorithm I had been using for tracking would not meet my performance requirements. I devised a new, motion segmentation-based solution which turned out to have better performance than I could have ever hoped from my original approach. The mindset of not becoming attached to any particular solution to a problem, and of being willing to backtrack in order to generate better results, has served me well, both in and out of research settings.

In ensuing years, I grasped the opportunity to work on a variety of rewarding, self-directed projects. I developed industry experience by starting an open-source software project (Orangemesh, a wireless network management tool) and completing a Program Management (user experience design) internship at Microsoft. While not research, both these experiences contributed to my understanding of the impact computers and computer scientists have beyond academia and taught me the importance of human-centered design in software.

In my junior year, as a semester project for my graduate-level Data Mining course, I developed a hybrid classification technique for predicting hurricane landfall potential based on early hurricane track measurements. By combining the results of both a simple k-nearest neighbor (k-NN) classifier and a more advanced Support Vector Machine-based classifier, I was able to predict with an accuracy of over 80% whether a tropical cyclone would make US landfall given the first 48 hours of tracking data. I conceptualized, implemented, and tested my hybrid classifier, and discovered that with the proper distance metric, the simple k-NN classification technique rivaled the performance of the mathematically sophisticated SVM classifier.

In the summer of my junior year, I participated in the NASA Undergraduate Summer Research Program and worked in the Operations Planning Software Lab (OPSLab) at the Jet Propulsion Laboratory. One tool my group was just beginning to explore to help support the lab's ongoing science missions was a large multitouch display wall. My project was to develop a software framework and recommendations for best practices for future multitouch software. I evaluated several different software architectures before settling on a "behavior stack" model for multitouch software development, an architecture inspired by a similar ones used in robotics. In my framework, developers define a set of "behaviors" for their application, such as a physics engine or gesture recognizer, as well as a hierarchy for these behaviors. A complete multitouch application is created by simply selecting a set of desired high-level behaviors. This modular architecture facilitates reuse of code and rapid development, two hugely enabling factors which will allow my team to quickly and effectively create new multitouch applications. I used my framework to develop a demonstration application for browsing mission data from the Mars Exploration Rovers, a tool to enable limited multitouch gesture support for existing desktop applications, and a data logging module to facilitate usability studies of multitouch applications.

My work at JPL was an immensely educational experience. While I worked largely independently on my project, I was also part of a software development team that used agile programming methodologies to efficiently produce high quality software. Because of this, my code had to be well-documented and designed for reuse so that others would be able to extend my work in a production environment after I left.

By my junior year, I had come to believe that innovations in networking could be extremely enabling for underserved populations by lowering the cost and increasing democratization of communication. Since then, my primary research focus has been in networking and protocol performance. Simulation of network traffic in controlled experiments underpins much important research in the networking field and is essential for repeatable, scientific study of network protocol performance. However, the nature of the impact that traffic simulation techniques have on performance measures is poorly understood. My work has focused on analyzing the effect of connection structure on performance indicators using a novel realistic model of modern internet traffic (described further in my research proposal). A significant portion of networking literature relies on over-simplified models of internet traffic in their experimental design, and my research aims to identify what properties of a protocol performance are overlooked as a result of poor design.

We have uncovered a number of unexpected results that are only apparent when performing analysis using a realistic model. For instance, in the vast majority of Internet traffic, network delay turns out to not have a dominating effect on performance; instead, intra-connection periods without any data transmission (known as "think times") play the largest role. My senior honors thesis involves replicating our experiments over the past year on a different input network trace to isolate performance characteristics that are endemic to a specific trace from those that are actually results of variation in traffic generation schemes.

In the course of my research, I have also developed tools to enable more thorough investigation and dissemination of our research results. One such tool I created makes our research more accessible to visiting K-12 student groups. Networking research, while intellectually stimulating, does not lend itself to glamorous demonstrations. To make it more accessible to our visitors, I wrote a program that integrated with our research tools to produce real-time visualizations of network performance measures. I also developed a tool my research group is currently using to monitor router queue lengths on millisecond timescales, which has proven essential to evaluating the impact of traffic generation techniques on router queuing, a major determinant of network delay. All told, this research has given me a deep and thorough understanding of the subtleties of major network protocols. I believe this understanding has prepared me well for future research in networking and for developing the network technologies that will be needed for connecting the next billion Internet users to the global network.