Background and Future Goals

During my undergraduate studies I slowly come to understand the context in which I would like to continue my studies. My experiences as a lab instructor at Tufts, as well as my time in Hong Kong last summer have made it extremely clear that I want to work in higher education, with the goal of promoting international collaboration, specifically between the US and China. I have thoroughly enjoyed my coursework and research at Tufts to the point which I know that I would like to continue to study computational applied math in a PhD program, and hopefully an eventual professorship. As a result I am looking to the GRFP as a way to help me on my path towards these goals.

Research

I have worked with the Soft Matter Theory research group at Tufts since spring 2015. The Soft Matter Theory group is a theoretical, computational physics research group at Tufts, [redacted]

The group is sma[redacted] however my work was independent of his in the sense that I had nearly complete freedom in the way I was allowed to implement my ideas. [redacted] for the most part my work was independent.

[redacted] required simulations to be run on the Tufts supercomputing cluster. In short, these simulations involved calculating the forces each particle felt at a given time, moving all of the particles accordingly, increasing the time and repeating. Given N particles each which can exert a force on one another, there are roughly N^2 forces to calculate. However, in our simulations, particles only interact with particles they touch (unlike a simulation of gravity, where every pair of particles interacts). As a result, any given particle interacts with only a small subset of the particles in the simulation. This makes it unnecessary for every particle pair to be examined.

My work took advantage of this, and sorted particles based on where they were physically located. Then, instead of trying to calculate the force each particle felt from every other particle, only the neighbors were examined. Since the time it takes each particle to check its neighbors is roughly constant, the new algorithm had a linear dependence on the number of particles. This means that my code could run simulations much quicker than the original code, especially when there are a large number of particles.

To achieve this, I had to become not only familiar with the code and numerical methods the team was working with, but with computing in on a scientic computing cluster. As a whole my work with the soft matter theory group has introduced me to the world of scientific computing and given me insight into the possibilities for continued study in this area.

This past semester I participated in the Research in Industrial Projects for Students Hong Kong (RIPS-HK) IRES, sponsored by IPAM at UCLA (NSF grant: 1460018). During this program I worked with other american students as well as local Hong Kong and Chinese students on an industrial project for the Hong Kong startup [redacted] helping them to lay the foundation for an underwater acoustic communication protocol to be used in their underwater robots.

High frequency electromagnetic waves commonly used for communication (cellphones, WiFi, etc.) dissipate extremely quickly underwater, and low frequency electromagnetic waves require large antenna. Acoustic communication underwater is possible, but there are some differences from electromagnetic waves. Since acoustic waves travel much slower and reflect more easily than electromagnetic waves (in normal use), the protocols used for electromagnetic waves cannot be efficiently be applied directly to acoustic communication. Over the past few decades research into acoustic underwater communication protocols for sensor networks has become an increasingly popular area of study.

Our summer work cultimated in a report for [redacted] which addressed many of these issues, and possible directions for further research.

Teaching

Last spring I was asked to teach a lab session for the physics lab course "Electronics" by [redacted] Before each lab students are asked to complete a pre-lab assignment, meant to introduce them to some of the key concepts of the lab. Before each lab I then grade the students responses, and discuss with them any issues which I feel they may run into based on their responses. I then assist the students with completing the lab. Each lab requires that students work with new tools and circuits with which they may not be familiar. As a result, it is my task to make sure that the students learn how to use these new tools.

This position has been extremely useful to my development as a hopeful future educator. First, it placed me directly in a position where I was responsible for teaching others. This gave me the opportunity to start to learn about effective ways to communicate my knowledge to others, who are unfamiliar with a topic. I learned that oftentimes the way I think about a problem isnt the way other think about it, so learning to rephrase or restructure an explication to fit a students framework is important.

I have been asked to run all of the upcoming lab sessions when the course is taught again this spring.

Since Fall 2014 I have graded for the Tufts Math Department. This involves scoring individual assignments for students in a variety of classes. Through my work as a grader I learned to provide concise feedback which is clear and helpful. I have also started to gain a better understanding of what makes a homework assignment successful, and how problems which actually help to build students understanding and knowledge can be selected.

Together these experiences have cemented my desire to continue in academia as an educator.

Broader impacts

As I mentioned briefly, I want to promote the cross-cultural exchange of knowledge, specifically with China. Since the start of the reform era in the 1980s, China has quickly risen in economic an academic strength. I think that it is beyond question that stronger academic ties between the US and China has the opportunity to allow for rapid accumulation of new knowledge in the near future. Improving the ties between the academic communities in the US and China will allow for easier sharing of knowledge in the future, and hopefully for a greater overall rate of progress.

[redacted]

When I was admitted into the RIPS-HK program last spring I was very excited. I knew that it would be a great opportunity to immerse myself in a different cultural environment, and begin to build relationships with young academics abroad. In my view, the most important part of the program was not the research we did, but rather my interactions with the Hong Kong students and faculty at HKUST. It was a unique opportunity for me to work not only in a small group environment, but also in an intercultural group, and given the composition of teams, each day provided the opportunity to work on communicating ideas across language and culture barriers. Beyond just working with these individuals, we were encouraged to spend time outside of our studies exploring life in Hong Kong and China, something that I think was a vital part of the program.

In my opinion, a significant factor in driving research forward, are local factors. Things such as the source of funding, whether or not the university wants to support research into an area, and whether others at an institution also study a topic all depend on to some degree on geography and culture. Given that this is the case, in order to collaborate successfully, it is important to understand the cultural context that your collaborators are working in. When working with someone from another US university, this is often not hard, but when working across country lines, especially with China, this is certainly an important topic to deal with.

I feel that my background has prepared me to effectively work in such a setting. My proposed research plan involves collaboration with researchers at Chinese universities working a similar topic to the one I propose. I believe that collaboration on any project should be encouraged as it will only strengthen the overall bond between our two countries. It is exciting to me that with modern technology, communicating and working with the other side of the world on specific projects has become increasingly possible. As a result, we now have the potential to rapidly increase human knowledge through collaboration between these groups, and I think that it is very important that the next generation of academics be fully committed to such collaboration.