Science is inherently collaborative, with scientists constantly extending the work of their peers and predecessors. I am motivated to facilitate this process, both by encouraging collaboration (across geographic borders and academic disciplines) and by lowering the systemic barriers which keep today's young scientists from reaching their full potential.

RELEVANT BACKGROUND: I have worked on collaborative and interdisciplinary research projects across the world. Simultaneously, I have actively contributed to the broader STEM community through my teaching and outreach. **My diverse background has allowed me to uniquely contribute to the projects and initiatives I have been a part of.**

Research: My research journey started in a computational soft matter physics group at Tufts where I helped to model the packing structure of small deformable spheres constrained to curved surfaces. During my time with this group I rewrote the core simulation algorithm to exploit the short range nature of the interaction potential between particles. As a result, **I reduced the runtime of our simulations by multiple orders of magnitude**, effectively turning overnight jobs into ones which could be run in minutes. This speedup facilitated faster experimentation, allowing the group to spend more time running experiments and thinking about physics and less time waiting for simulations to finish. I realized the power of using algorithms designed specifically for the problems they are applied to, as well as the hardware they are run on. At the same time, I realized that research code is often poorly written, both in terms of asymptotic complexity and human readability. I saw first hand how messy codebases hinder future extension and make reproducing past results much more difficult. As a result, **I now write code that future researchers will easily be able to build off of**, and regularly attend talks and seminars on how to do this better.

In the summer of 2016 I crossed an ocean to participate in the NSF funded Research in Industrial Projects Hong Kong (RIPS-HK) program. **The RIPS-HK program strongly emphasizes cultural exchange and international collaboration** by grouping American and Hong Kong/Chinese students together to work on a summer long research project in industrial math. My group laid the groundwork for a communication protocol for undersea autonomous robots using acoustic waves (since standard protocols such as WiFi and LTE do not work underwater). My background in physics and math helped our group to overcome challenges relating to the complex interaction of sound waves with the undersea environment. The project culminated with presentations at the University of Macau and Hong Kong University of Science and Technology (HKUST) where audience members included NSF director France Córdova, NSF China office head Nancy Sung, and HKUST president Tony Chan, each of whom I was able to meet in person to talk about my work.

These projects helped solidify my desire to understand the theory behind computing. I am now a PhD student at the University of Washington (UW) where I work in the field of numerical analysis, studying the practical behavior of algorithms when they are implemented in finite precision arithmetic. **This field plays a critical role in ensuring that the algorithms scientists use actually give accurate outputs.** I currently work with Anne Greenbaum on the study of parallel variants of the conjugate gradient method (CG). CG is a widely used iterative method for solving a class of linear systems which arise from many applications, including simulations of physical systems. Our hope for this project is to develop a parallelizable CG algorithm with has better numerical properties than the current algorithms which do not always produce accurate results. Our numerical tests have suggested a simple set of criterion for good convergence, which we are currently working to prove analytically.

Teaching: My teaching is motivated by the fact that there is rarely a single best way to solve a problem. Often the problem solving process itself is just as important as the answer, so encouraging active engagement is a driving principle in my interactions with students. At Tufts I was the instructor for the lab component of the electronics course in the Physics department for two years. This was my first time teaching college students and galvanized my desire to teach in academia. During my two years **as instructor I worked closely with Roger Tobin to develop the course curriculum**, as well as improve my own teaching and interactions with students. In the lab sections I provided both a theoretical background and oversaw hands on circuit building and analysis. I focused on ensuring that students were building good intuition for the physical systems they worked on, as well as on emphasizing understanding and problem solving through experimentation with the circuitry and lab equipment. At UW I have led recitations for various calculus courses where **my sections consistently score higher than the class medians** (my medians: 3.2-3.3 vs. class medians: $\sim$3.0). I believe that this is because I encourage participation and learning by trying to create environments where students feel comfortable being themselves.

FUTURE GOALS: Broadly, I intend to develop efficient algorithms for high-dimension problems.

During my PhD I plan to work on parallel and randomized Krylov subspace methods. Krylov subspace methods are among the most successful and widely used iterative methods for computing eigenvalues, matrix functions, and solving linear systems. **These tasks underlie all of numerical linear algebra, and have a applications in nearly every field of science**. As our ability to gather and store data rapidly increases, algorithms designed explicitly for big data must be developed.

Two common approaches to speed up algorithms are parallelization and approximation. Parallelization generally means running multiple parts of an algorithm simultaneously (for example saving time by having multiple cashiers to help different customers at once). On the other hand, approximation algorithms generally gain speedups by finding close optimal solutions, rather than exact solutions (for example a cashier saving time by making reasonable guesses about the price of fruit rather than looking up the exact price). **My background in computing, probability/stochastics, and applied math puts me in a strong position to be able to incorporate both approaches into existing Krylov subspace methods.**

I will also continue to TA, until I am in a position to be the primary instructor for undergraduate courses in our department (likely towards the end of my third year). At the end of this year I plan to run for the department position of Graduate Student Representative (GSR), a role typically taken by a third year student. As GSR I will have more opportunities to directly improve the quality of life of graduate students in our department.

Following my PhD I hope to work at a liberal arts school which has a strong mission of social justice and education equity. My time at Tufts showed me that an institutional commitment to service initiatives can empower students who would otherwise be excluded to contribute to STEM. It is my desire to follow in the footsteps of the professors I had there.

INTELLECTUAL MERIT: My background is highly interdisciplinary, evidenced by my successful contributions to projects in a range of fields. For example, being able to understand the subtletites of the physics in play have allowed me to write fast simulation algorithms and understand how to extend existing electromagnetic wave communication protocols to acoustic waves. More generally, **I am able to effectively collaborate with researchers from other disciplines, helping to synthesize everyone's individual ideas into a coherent big picture** because I am familiar with the varying methods and approaches which are used in different fields.

I was accepted to PhD programs in computational science, math, and network science, but ultimately chose my current program because **the Applied Math department at UW actively encourages collaboration with researchers across the University**. I have taken advantage of this flexibility by attending research meetings and taking classes in the computer science and math departments regarding randomized algorithms and approximation approximation algorithms. This has expanded the toolbox of methods available to me for my own research.

BROADER IMPACTS: I believe in empowering others to contribute to science. This means doing research which will help scientists tackle the big problems of today, as well as helping to build up the next generation of scientists who will be able to carry on the vision of an accessible and inclusive academic community. I aim to lower institutional barriers which keep students from begin successful in academia. **This has manifested in activities such as, working a union organizer to fight for better grad student wages, organizing an event on mental health in grad school, collaborating internationally, and promoting open and accessible knowledge.**

International Collaboration: My experience in Hong Kong affirmed the effectiveness of research exchange programs at promoting international collaboration, and I believe that such collaboration is necessary to fully take advantage of the potential both countries have for scientific discovery. My grandparents are mathematics professors in China, and their students, who now hold faculty and administrative positions throughout the Chinese university system, have repeatedly encouraged me to study in China. As a result, **I am in the unique position of being able to help strengthen the academic ties between the US and China.** This especially critical in light of the US government's current approach to foreign affairs and scientific funding.

Mental Health: I know first hand how difficult it can be to seek and find care for mental health concerns. In the hopes of destigmatizing talking about mental health, I do my best to be open with my students and peers about my own experiences and treatment. To help address the fact that graduate students are more that six times as likely to experience disorders such as depression and anxiety than the general public[1], **I organized an event regarding managing mental health during grad school** and what local resources are available. I intend for this event to become a yearly happening, and if elected GSR, I will be in a position to work more directly with the department to provide official department outreach regarding mental health.

Open Knowledge: I am a proponent of open source software and educational resources. Access to a quality education should not be dependent on socioeconomic status or geography, and forcing students to pay for software and textbooks places unnecessary burden on students from underprivileged backgrounds. **I currently maintain public repositories containing hundreds of pages of my personal course notes, worked problems, qualification exam preparation materials, and code for homework assignments.** In particular, I have ported every MATLAB program which has been part of an assignment to an analogous openly available python program so that future students will not need to pay for MATLAB in order to take courses in our department.

Similarly, research code should be written with accessibility in mind. As I learned through my past research, even when academic codebases are open source, they are often extremely difficult to use. This is detrimental to reproducibility, and more practically, slows the adoption of new knowledge and techniques. **The less time scientists have to spend working through convoluted and difficult to use code, the more time they can spend focusing on their own research and tackling the problems of today.** I am committed to writing portable and extensible code and regularly participate in journal club discussions on good coding practices for scientific computing.

[1] *Evidence for a mental health crisis in graduate education*, Nature Biotechnology, 2018