Personal Statement - Steven Walton

I grew up on sci-fi books and Star Trek. This had a lasting impact on how I view the world, showing how science can change peoples' lives and the ethical decisions that need to be made. Growing up with role models such as Isaac Asimov, Carl Sagan, and Captain Kathryn Janeway, I have always been aware that while science can greatly advance peoples' lives, there are new ethical dilemmas that arise. As another role model might say: "With great power comes great responsibility." As a researcher I want to act in a way that I believe would make these role models proud. I believe that this requires me to: be part teacher, ensuring that my work is accessible and available to others; part researcher, being creative and performing the best work that I can; and part philosopher, questioning the impacts and ethical dilemmas of my own research.

With the rise in popularity of Artificial Intelligence and Machine Learning it is becoming clear that these ethical dilemmas are growing and frequently being unanswered, or ignored. Conversely, the rise in AI research has helped push for more open science, where papers are being published to locations such as ArXiv and code is being open sourced on platforms such as GitHub. I believe that by encouraging open science helps everyone, from scientists to the public.

With open science I believe the public can be more informed with current research and help ask and answer the ethical problems that arise. When science is locked behind paywalls it causes gate-keeping that only hinders everyone involved, especially the public and those in impoverished neighborhoods and countries. Open research leads to higher reproducibility, catching more mistakes, and allows the public to be involved in the process. Specifically, I believe that publicly funded work should be open for all, as it is the public who has paid for the work.

Having worked on several open sourced scientific projects as well as closed source, it is apparent to me that open sourced projects are more readily adopted by the scientific community. It also provides a direct line to the developer and the users, which leads to higher quality software and a better understanding of user needs.

I have always been passionate about learning and trying to understand any problem that interested me. This lead me to pursue an undergraduate degree in Space Physics. While I was able to buy all the books that were required for my classes I found that these many times were not enough. An advantage that I had was that the material in undergraduate physics textbooks have not change much in the last hundred years. I found that sometimes that the way one textbook was written would be difficult for me to understand a topic, but that by going through several textbooks I could find one that caused the information to finally sink in. I found that the more resources available to me the better I performed.

As most physicists, my colleagues and I admired Richard Feynman. When we learned about the "Feynman Technique", which says that one of the best ways to learn is by teaching, we started to arrange our study groups so that one person would lecture on a problem and the rest would ask as many questions as they could. I found this exercise both challenging and exhilarating. By studying in this manner I found that both the technique worked well and that I had a passion for teaching.

From a young age I have always been interested in the sciences and engineering. I grew up on sci-fi books and Star Trek. After I had destroyed a lot of things in our house, attempting to figure out how they worked, my dad started handing me broken things and challenging me to fix them before he bought replacements. I have always had a strong desire to understand how everything works, from the microscopic and mundane to the large and exciting areas.

When I applied to university I was accepted as an aerospace engineer. I wanted to explore the stars and thought that this would be the best way to make that dream a reality. Before the semester was even over I had changed my degree to Physics and working on a research project with the physics chair. I was more interested in the toolbox that Physics gives to understand the world than strictly building things. In experimental physics I found a nice balance between doing hands applications and trying to understand things from a very basic level. This passion continued to grow and I started taking on more projects from other professors.

My passion for the stars led to a professor asking me to help with running the school's telescope and getting involved in outreach programs. Our university would run science events a few times a year for students and members of the community. We'd do events mainly around astronomical events like solar eclipses, the Venus transit, and lunar eclipses. During the day events we would set up a lot of different physics experiments that would get community members interested in science and talk about the individual phenomena being demonstrated. At night events we would bring out laser pointers and tell some of the history and legends surrounding constellations. From these experiences I developed a passion for teaching and became a TA for several of the physics classes. I took a passion to trying to design lessons that would challenge students but also keep them excited and engaged. I also found that his resulted in me having a deeper understanding of material and caused me to approach problems from different perspectives.

In undergrad I also got professors to give me extra access to different labs so that I could do research on my interests during my free time. Though the kindness of these professors I developed a deep passion for research. I felt that this access gave me the time to really dig into problems and concentrate on solving problems. The free reign gave me the ability to explore topics that I would not have been able to during classes and I believe helped develop my methods to solving complex problems.

While in my undergrad I started programming a lot more. I had had a few introductions to programming and computer science before, but had never had to write anything complicated before. With some of the research the professors had given me I had to start writing complicated code and gain a deeper understanding of how programming works. At this point I found programming interesting but it was a means to an end.

After graduating I obtained a job in Tennessee to work at a rocket company. There I was able to work on low level research in conjunction with NASA and the University of Tennessee Knoxville. While there I wrote and won a Phase I NASA STTR proposal. My employers gave me the lead position on the project, where I was in charge on planning, running the experiments, and handling the communication with our University partner (University of Tennessee Knoxville). My success in this directly lead to Phase II funding and a continuation of this work. A large part of this work

was performing computational simulations and then building and testing the resulting materials that the simulations predicted would have the best performance. This was my first time working with large and complex simulation code and I found that I really enjoyed it. I found that programming really resonates with the way I think and I found it exciting to build simulations that made real world predictions and that I was making real contributions to science.

With a few years of work under my belt I decided that I wanted to further continue down the path of the intersection of computer science and the physical sciences. There were new topics that I had been excited about and teaching myself but felt that this would be more efficient if I could get a mentor that could help guide me to the right problems and refine my abilities. I found the HPC visualization at the University of Oregon (UO) and applied for a PhD program, where I was accepted and have been a student for a year.

While at UO I have been able to work on scientific visualization projects. I believe my broad skill set has has been added value to our research group as I can help bridge communication between the domain scientists and the visualization experts. Through my current advisor I have had the opportunity to work at two Department of Energy (DoE) National Labs: Oak Ridge National Lab (ORNL) and Lawrence Livermore National Lab (LLNL). I got the first internship at ORNL the summer before I entered my PhD program. This gave me my first real introduction into HPC and how the environment worked. During my second summer I was given the opportunity to work at LLNL and given the freedom to pursue my own interests. Here I was able to improve both my understanding in machine learning and visualizations in HPC. Over the summer I attempted to interpolate scientific data through machine learning, the project described within. There were some successes and failures in this, but I gained a better understanding of how to approach the problem and what tasks need to be solved within. Through my experiences here I believe I would be most happy working either in academia or at a lab, continuing research and helping mentor new generations of scientists.

Intellectual Merit With my background in physics and mathematics coming over to the computer science field I believe that I am in a unique position for a project such as this. My strong math and physics background has already enabled me to help my research group bridge gaps in communication between domain scientists and visualization experts. It is not uncommon for miscommunication to happen between different research domains, as researchers may be using similar words but in different contexts. This has helped our group better understand what domain scientists are looking for, but may have a difficult time communicating. Having come from a background of performing simulations, it is easier to intuit what a simulation scientist is trying to accomplish.

My strong background in mathematics has enabled me to quickly catch up with modern machine learning techniques and understand the underlying statistical properties of models. Being in a computer science environment has helped reduce my so called “Swiss Cheese” knowledge in computer science and HPC and allow me to progress towards expertise.

Broader Impacts I believe that one of the most important duties of a researcher is being able to communicate their work. Scientists like Sagan and deGrasse Tyson have impacted my life and I believe the how they communicate should be emulated. I have greatly enjoyed my experiences

teaching classes and would like to become a professor in the future. I believe that becoming a professor would allow me to follow through with my passion for research and teaching.

Additionally, I am passionate about open source software and blogging. Personally, I have benefited greatly from both of these and blogging has enabled me to learn a large breadth of subjects. In an effort to contribute back to the community, which has helped me so much, I try to open source as much software as I can and write in my blog about what I am learning. I believe that a NSF fellowship puts me in a position that will encourage these passions. Not only will it free up time to enable more blogging of my research, but through a public funding I am not restricted from open sourcing my research and having the research be in the open.

I believe that by open sourcing and blogging about my research that this can more greatly enable reproducibility of results and push science to be more open. It is my belief that science is performed more efficiently when more eyes are able to see what is being done and more people are able to perform research. With funding through the NSF, I am able to perform research without constraints of visibility and can perform my research in the open.