"Oh no, it's fine, I'll just wait for *him* to help me," the student tells me, the lab's Teaching Assistant, as he points to my clearly busy male coworker. I sit back, feeling useless and undermined by a cocky freshman. I knew going into computer science would be challenging, but days like this made it difficult to feel like I belonged in the field. As the students filed out of the lab, I felt an overwhelming sense of doubt. How could I fit in to this world dominated by techy guys?

I found my niche when I began searching for an honors thesis mentor during my undergraduate years at Oregon State University. I discovered Dr. Margaret Burnett's work on GenderMag, a method for identifying gender-inclusiveness issues in software interfaces. Her research piqued my interest: could gender inclusivity in software interfaces eventually promote societal and organizational change? I decided then to get involved in her research and learn more about the potential of pairing computer science and social justice.

In Dr. Burnett's lab, I researched aspects of gender equality in software and its potential to create software that supports all users, regardless of gender, ethnicity, socioeconomic status, or ability. This, in turn, inspired me to investigate how social justice could also be relevant and impactful to other fields of computer science, which spurred my pursuit of research in machine learning (ML) and neuroscience. I find the idea of decoding and modeling the brain -- our thoughts, feelings, and emotions -- highly important, complex, and research worthy. Science fiction warnings aside, I worry that our pursuit of artificial intelligence could cause us to forgo ethical and social justice issues vital to our future. **As ML and neuroscience develop, we must maintain a social justice perspective to ensure that our research leads us toward the values we aspire to in our culture.** This is an agenda that I hope to develop during my PhD research at the University of Washington.

Intellectual Merit

For my first research project with GenderMag, we investigated how a software tool could ease the process of finding and analyzing gender inclusiveness issues, such as inadequate error feedback that does not tell users how to fix the problem [1]. I learned from the project how to conduct user studies, and additional GenderMag projects further expanded my knowledge of the research process. I helped to design, run, analyze, and write for research projects such as GenderMag Teach [2], GenderMag Open Source [3] and GenderMag Best Practices [4, 5]. I also wrote an honors thesis on specific fixes to promote gender inclusiveness in software interfaces [6], which gave me the opportunity to combine the technical writing, data analysis, and public speaking skills I learned during my years in the lab. These experiences also highlighted how my research contributions can make a difference for women in technology by educating people on the subtle biases in software interfaces that disproportionately hinder women from fully engaging with software systems. As a direct consequence of these projects, more than 10 universities now teach GenderMag in CS classes, open source projects have started to use GenderMag to solve newcomer issues, and Oregon State University incorporated GenderMag into its new diversity initiative.

In my Junior year, I enrolled in a Brain and Behavior class, where I learned how the brain develops, how neurons adapt and build connections, and how these processes affect behavior. I became intrigued by the idea of using computational methods to decode and model neurological processes. Neuroscience research differed significantly from my GenderMag work, but I believed the field could also provide an opportunity to make a societal impact. Feeling confident in my research abilities and wanting to explore this area, I accepted an NSF REU position in computational neuroscience at the University of Washington.

During the REU, I worked with Dr. Stocco, a psychology professor specializing in cognitive science. Both he and the Center for Neurotechnology showed me various accomplishments in brain research, from developing treatments for Parkinson's disease to achieving "mind control" by interpreting brain signals from one person and sending them to another. For my project in cognitive modeling, Dr. Stocco, a postbac student, and I worked on analyzing the Common Model of Cognition (CMC) with human brain data. We wanted to determine whether the CMC was an accurate way to describe how the human brain transfers information. To answer this question, I spent the summer researching alternative cognitive models, running MatLab data analyses on brain data, and managing the big data we used. Our research found that the CMC explained brain behavior more effectively than all other cognitive models, validating it as a strong model for the cognitive architecture of the brain. Because of my dedication and passion for the research, I was first author on a paper describing our research [7], submitted an abstract to a conference where I presented this work (Brain Informatics '18), and co-authored another paper to extend this research [8]. **My opportunity in the REU further boosted my confidence in my ability to learn and adapt to new research areas, make socially beneficial research contributions, and reinforced my interest in pursuing a blend of ML and neuroscience for research in graduate school.**

Wanting more experience in ML, I pursued an ML project for my senior design class that involved developing an ML system to help people practice public speaking by detecting filler words (such as "um," "uh," and "er") and alert them when they used these words. To do this, we adapted the Mozilla DeepSpeech framework to transcribe filler words from speech to text. However, this proved to be more complex than originally thought; since Mozilla Deepspeech uses a supervised learning algorithm, we needed data labeled with filler words, which most transcriptions do not include. Since we could not find any datasets that had the labels we needed, we developed our own. Although this limited system robustness, the model still had a true positive rate of 73%. Through the project's ups and downs, I gained valuable skills in ML by experimenting with a real-life application.

Broader Impacts

My research experience with Dr. Burnett not only taught me to ask research questions that contribute to the greater good, but it also showed me how to give back through science mentorships. Dr. Burnett focuses her mentorships with underrepresented and/or underprivileged students and encourages her mentees to do the same. While working with her, I mentored high school students through the Apprenticeships in Science and Engineering (ASE) program, which gives high school students the opportunity to work in a research lab for a summer. One of my mentees was in the foster care system, and through our encouragement in the lab, he applied to and was accepted by Oregon State the next Fall. **Seeing my mentee attend college and become excited about research illuminated how I could use my position to help others explore their passions and act as a role model for younger students.**

Beyond my research positions, I also pursued impactful experiences on a global level. This pursuit began with my Chinese Immersion educational experience (K-10) and continued into my college years through service opportunities with the Honors College. Spending ten years learning Mandarin expanded my worldview as I became more of a global citizen: I spent time in SuZhou, China, where I helped develop the international community between my school and our sister school. When I went to college, I continued my international work through the Honors College, which organizes annual international service trips. With this program, I spent spring break 2018 in rural Nepal, helping locals at the bottom of the caste system build a community center for their

village. My international experiences, combined with my interest in mentoring, give me a unique opportunity to engage in international mentoring in the future.

Future Goals

My work in human computer interaction gave me the chance to do research that was personally meaningful, by integrating social justice and computer science, and I will continue to seek connections between these fields during my research in computational neuroscience at the University of Washington. **During my PhD, I intend to take the scientific community one step closer to ethically modeling the whole brain** so I may one day be recognized as follows:

"Digital Mind pioneer Zoe Steine-Hanson is one of the distinguished and creative forces behind biologically inspired artificial human brains. Her undergraduate degree in computer science, combined with her interest in neuroscience, motivated her work on brain computer interfaces and machine learning in her graduate years at the University of Washington. After receiving her PhD in 2025, she began her seminal research on cognitive architectures at DeepMind. While there, Dr. Steine-Hanson helped to develop the first Digital Mind, a full-function digital replica of the human brain. Since then, she has continued her innovative work on digital brains, finding new ways to apply Digital Mind to neural prosthetics, mental health, and ML theory. Throughout her career, she also worked with underrepresented groups in technology and computing, helping high school students in the United States and abroad generate an interest in technology." - Wikipedia entry for Zoe Steine-Hanson, 2065

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