Personal, Background, and Future Goals Statement

I wasn't aware that for months, my family had been unable to make timely mortgage payments. Only a year ago my mother had been dealing with I.C.E., was in immigration detention for her undocumented status, and lost her job. I was a middle schooler at the time. When the eviction came in and I was told we had a day to move out, I was taken aback. In the years that followed, my family didn't want to talk about how hard life had become. They came to the U.S. to escape from poverty in Mexico, and they were ashamed of their setback.

Looking back, I realize how my response to the constant financial hardships and immigration court proceedings have helped shape me into a persevering, communicative, and creative person. While these traits are important in my life in general, they also influence me as a researcher. I have found that research requires similar perseverance in the face of temporary setbacks, consensus formation, effective communication during stressful situations, and creative exploration of problems.

As a graduate student, I have found meaningful research to be human-driven and interdisciplinary. I am confident that this kind of research has the greatest potential for direct impact. In this personal statement, I demonstrate that the skills I possess have supported my research and personal achievements. As I look forward to my future work, I will use my life lessons of **perseverance, consensus building, high pressure communication, and creativity** to both stick with and succeed at conducting research that is novel and reduces the barriers of exclusivity that exist in computer science.

Perseverance. College application deadlines were approaching, and I had been performing poorly on the ACT, scoring a 21 out of 36 at best. Between an hour commute home that was introduced by the eviction and my parents working evening and night shifts to afford immigration lawyers, after-school help was not an option unless I wanted to spend the night in the school parking lot. However, I was determined to get into an affordable and established college. So after watching Youtube videos and reading advice online, I bought a decade-old edition of the ACT Princeton Review and printed free online practice tests. I treated it as homework, taking a subject test going to school and grading it on the way back home. It worked. I raised my score up to a 28, opening up so many college options for myself.

Perhaps research may not throw evictions at me, but it still throws setbacks. During my first year as a PhD student, I became incredibly interested in interdisciplinary studies that utilized medical imaging techniques to understand cognitive processes. The use of medical imaging has been a relatively novel technique applied to understand common software engineering practices and findings have been used to improve teaching curricula in programming classes. Examining the literature, I had discovered a gap. How the quality of error messages impacts programmers at the neurological level had not been examined. After discussing it with my advisor, I proposed a medical imaging study to investigate the neurological activity of software engineers as they respond to compiler error messages. I had a goal to submit this paper at the deadline for our top-tier venue in six months. I started a series of meetings with professors and graduate student experts in the area to advise me in designing the experiment. I initiated a collaboration with Dr. Yu Huang, a professor outside my institution, and a 5th year graduate student. In three months, I had created stimuli, developed research questions, and started recruitment planning. The next step was scheduling a meeting with psychologist Dr. Ioulia Kovelman, who owned the medical device of interest. Unexpectedly, we discovered the medical imaging device would not be available until eight months later. The project would not be complete in time for my deadline. I would have to postpone.

I didn't allow this setback to dissuade me from my goal of a paper submission at the end of my year. I asked my advisor and research group members if there were other projects I could help out with while my project was on hold. Continuing my interest in debugging, I was interested in the start of a human study aiming to understand if the application of a circuit description automated repair tool could be used to aid in maintenance. Although I was familiar with automated program repair, I had little knowledge of circuit designs. Therefore, I conducted my own literature review of the project, met with a circuit design expert, and downloaded the circuit automated repair tool, upon which the study was built on, to understand its functions. I persevered, treating the new topic as an opportunity to learn more about

how a different type of empirical research is conducted. I successfully submitted a journal article of my work within a year, accomplishing my goal, in which I was first author. It is now under revision.

Consensus Building. My interest to become more involved within my community truly flourished as I started college. Given the complications I faced with college applications, I became a resident hall assistant with the aim to help students that struggled as I had. Aside from the administrative duties associated with such a position, I constructed and executed various outreach projects to help with retention issues. These included organizing informal dinner events in which fifty residents could meet with mental health counseling or career services. However, my most crucial role as an RA was helping residents handle conflicts and build consensus. For example, one of the first conflicts I handled was between two roommates disagreeing on the layout of their room. This particular type of tension can be very relevant for first-generation students and others who might be less prepared for living away from home. I met with both residents individually. I used that information to guide my work as a moderator. The conversation went smoothly and I was able to resolve the issue within two meetings. This approach worked well for short- and long-term concerns: after the initial issue, they both approached me later in the year for help with other aspects of their lives, indicating that they felt comfortable with me even after I moderated a compromise for them. My impact did not go unnoticed as I was later promoted to be an assistant area coordinator, managing other resident assistants.

The consensus building skills I've developed with the position have come to great use in my research career. After submitting the journal article, I resumed my initial research project on medical imaging. Knowing that scheduling was now available, I reached out to Dr. Kovelman and her research team with the aim of establishing an interdisciplinary collaboration. I was determined to build a consensus that would both support what I and Dr. Kovelman's group were interested in. In a series of meetings, I learned about their ongoing research, of which their work on dyslexia stood out the most to me. While reading prose languages, dyslexics demonstrate low phonemic awareness that impacts their reading. However, this phenomenon is currently under-studied in the research community. The diverse perspectives led to me proposing that we expand my current research idea of studying the neurological activity of programmers in response to error messages to also include the study of dyslexic programmers. I decided to pursue the following question: how do these individuals work around error messages as opposed to neurotypical programmers. One benefit that can be derived from this research is that we can further understand what characteristics of error messages support dyslexic participants. Both Dr. Kovelman and two members of her research team were interested in my consensus collaboration. I describe this project in more detail in my research statement.

High Pressure Communication. I believe my discussions with the psychology department not only show my ability to build consensus but also my ability to communicate in high pressure. I have found that it can be difficult to communicate foundational ideas as plainly and openly as possible. Interdisciplinary research may not be as fruitful without a collaboration to cover all angles of the topic being conducted, so the pressure was high. I effectively communicated my research idea and ended with a collaboration with the team.

These types of high pressure environments are not entirely new to me. Three years ago, my father submitted a Green Card petition in which I had to sign off on as the US citizen sponsor. The petition approval only implied my father could schedule an interview to determine eligibility and verify important information regarding his undocumented living in the United States. However, one thing they don't advertise is that a rejection could easily land you in the immigration detention site down the street of the interview location, leading to deportation. From constant meetings with lawyers and hiring expensive professional translators, the tensions were high. The day of the interview, I asked for the uncommon situation of sitting in as the interviewer interrogated my father about his past. Surprisingly, I caught the interpreter mistranslating a crucial response my father made to a question.

"When was the last time you entered the United States?" The question was simple. I watched my father indicate the right day, month, year, and approximate time in Spanish -- the same one written in the immigration documentation. The look of confusion and disappointment the interviewer had when the interviewer heard the interpreter translate an erroneous date made my heart sink. To the interviewer, my

father was lying under oath. Because I was only allowed to sit in and watch the interview, interrupting could easily be seen as rude or potentially incriminating; however, sitting silently would do much worse.

Waiting for the soonest pause in dialog, I gently asked the interviewer if I could interrupt with a concern. I let her know that I believed there had been a mistranslation between my father and the interpreter. The interviewer took my comment as an indication to ask again and clarify. The correction was made and my father made it through the interview. I can gladly say he received his Green Card.

Creativity. I have had many opportunities to seek creative outlets for problems in my life. For example, on instances in which I could locate a free textbook for a class online, I downloaded instead of purchasing it. To help my family with the difficulty of getting groceries, I often went to my school cafeteria and I asked about leftover breakfast bags I could take home. During high school, I used my free class period to work at the school mini-mart to save money for school trips and competitions. I accomplished successes in school while saving financially via these creative approaches.

Success in research requires this sort of creativity, and it has transferred to my research. As an undergraduate, I took up a research internship offer at Carnegie Mellon University. I worked with Professors Christian Kästner and Clarie Le Goues in exploring patch quality in automatic bug repair. The project was a high-level open-ended directive to look at patches. Extensive literature review aside, the most cognitive-intensive reading I did was going through 100+ patches developed by an automatic bug repair tool. My initial proposal was to qualitatively cluster patches based on a number of heterogeneous program properties. However, I dismissed this idea after noting that the clustering may only apply to a small range of programs with very specific attributes. For example, simply, programs can be very diverse in properties as well as diverse in the manner in which they are written. A successful qualitative analysis requires human labor which is expensive and time consuming.

I opted to quantify some patch characteristics and develop a deterministic algorithm. I constructed a metric that ranked a collection of patches. We used a test-based automatic bug repair tool under one test suite to generate patches for 28 buggy programs. After ranking these patches, I tested them on a second held-out test-suite to evaluate the effectiveness of my orderings. I found that around 80% of the rankings appropriately assessed my more favorable patches higher than my least favorable ones. The method was promising, and we published it as part of a systematic review of a prototype automatic bug repair tool.

These experiences are the foundations of the skills I now practice and strengthen as a researcher. These skills -- **perseverance, consensus building, high-pressure communication, and creativity** -- drive the current success I have in my career. As I progress on my research journey, I hope to continue strengthening my skills and further applying them to develop creative solutions to important problems much like the work I do now. I conclude by summarizing my intellectual merit and broader impacts:

Intellectual Merit: I have published a paper in the area of automatic program repair**,** transitioned to exploring the use of these tools for improving pedagogy in my under-revision journal article, to then further investigate the cognitive processes associated with how developers use such tools via medical imaging techniques. I demonstrate my ability to produce creative publishable solutions to problems in my first peer-reviewed work, *Varfix: balancing edit expressiveness and search effectiveness in automated program repair,* that was published in a top-tier software engineering venue. My journal article under revision shows my achievements in conducting rigorous statistical analyses of human studies. Aside from my successes in initiating collaborative research, my prior experiences have positioned me to conduct future interdisciplinary research.

Broader Impacts: I plan to implement the skills I learned by focusing on research that expands diversity and broadens participation in computing. My current work in evaluating the neural activity in dyslexic and neurotypical programmers as they conduct a highly-important task in software development has the potential to make real impacts that benefit marginalized groups. Although my interest in helping first-generation students and outreach commenced when I was a resident assistant at my undergraduate institution, it has continued throughout my undergraduate work on supported debugging tools for pedagogy and now underlies my graduate research direction in the intersection of software engineering and psychology.