Personal, Background, and Future Goals Statement

Personal Statement: My path to pursuing science is a testament to the resilience and determination that have defined my life. Growing up in a modest middle-of-the-line school amidst some of the best private and public high schools in the greater New York City area, I faced unique challenges in my pursuit of contributing to scientific problems. **I had a deep passion for computer science and autonomous systems at a young age**, but the limited opportunities available in my area were predominantly reserved for those attending the several elite high schools around me. The absence of mentorship in research until college influenced me to forge my own path through competitive robotics and studying online courses, where **I learned to grow independently**.

As a second-generation American, born to first-generation immigrants from Poland and the Philippines, I am the first in my family to pursue higher education. Growing up in a low-income household with minimal family guidance profoundly influenced the trajectory of my life. I've been in survival mode since high school, steadfastly focused on not only achieving personal growth but also on providing for my family's well-being.

By the time I reached college, **I had become largely self-sufficient**. This journey has been fraught with challenges, but it has also been marked by growth, resilience, and an unyielding determination to make the most of my limited opportunities.

I consider myself immensely fortunate to stand where I am today, not as a product of my unfortunate circumstances but as a result of the grit and perseverance I've developed along the way. **It is an honor and a privilege to have the opportunity to pursue graduate studies** in a subject I love.

Relevant Background, Motivation, and Intellectual Merit: I'm passionate about integrating AI into our daily lives. **My main interests are in interactable autonomous systems**, specifically, collaborative decision-making between autonomous systems and humans. I enjoy studying how to build virtual and embodied systems the general population can interact with. Naturally, the main fields I'm most interested in are artificial intelligence, robotics, and human-robot interaction. I am also interested in subfields that aid in building interactable systems, like machine learning, computer vision, natural language processing, and large language models.

My passion for research was sparked while I was in high school, a time when it seemed like science fiction was becoming reality. The initial inspiration came from viewing the first demos of Tesla Autopilot, which opened my eyes to the possibility of self-driving cars. This was a time when the field of deep learning and big data were rapidly gaining momentum, with exciting AI breakthroughs in problems like object detection regularly appearing on platforms like YouTube. While I may not have fully comprehended the implications at the time, **I was captivated by the prospect of designing systems capable of intelligent decision-making**, ultimately assisting humanity in solving complex challenges.

I was encouraged to join the VEX Robotics team in my junior year of high school and was immediately **immersed in all of the complex problems surrounding creating autonomous systems**. This is where I was first introduced to the classic robotics stack of perception, localization, planning, and control. I led the software development for all of my school's teams, and I led a competition team. I engineered and programmed robots for 2 annual competitions, and won Excellence, Design, and Tournament Champion awards. I was a State and World Championship competitor.

Shortly after joining the VEX Robotics team I also founded and led my school's Zero Robotics team. Zero Robotics was unique from VEX Robotics since the programming was done on reliable satellites in simulation instead of physical student-built robots. The goal of the competition was to develop autonomous planning for retrieving satellite debris in space. I was able to hone in on learning a few classical artificial intelligence techniques specifically for path planning. My team advanced to the finals of the competition, and **my program was run live aboard the International Space Station** on a robotic free-flying system.

I joined the Duality Laboratory at Purdue as a Freshman and spent 1.5 years reproducing novel computer vision models from the machine learning library Pytorch into another library TensorFlow. This was a paid collaboration between Purdue and Google. I developed parts of TensorFlow's YOLOv4 and Mesh R-CNN re-implementation as a student leader. I met weekly with Google engineers and the other laboratory

leaders to publish the lab's work into the TensorFlow Model Garden. I **hyperparameter-tuned the Duality Lab's reproduction of YOLOv4-Tiny** and delivered a comparable set of weights to the original implementation. I also found a large bug wherein training certain models on tensor processing units causes memory leaks. My development of data pipelines and internal tooling was also adopted within the laboratory. This was a rapid introduction to deep learning and software engineering for machine learning and **formed the foundation of my knowledge** for my later experiences. Although I'd go on to formally study machine learning and computer vision in classes later, **this is when I started gaining an intuitive understanding of neural networks**. I learned how to understand latent space representations, and how certain architectural blocks in modeling can create better latent space representations than others.

My journey in college also involved participating in hackathons, where I gained valuable engineering knowledge over a few weekends. I competed in 5 hackathons total and won awards for 2 projects. **At HackRPI 2020 my team won: Best Use of AI, Best Use of Google Cloud, and Top 15 Overall. At Purdue's freshman hackathon 2020 we won 2nd Place Overall**. I mainly focused on backend development and was exposed to a wide range of concepts in software engineering.

During my involvement with the Duality Laboratory, I became an active member of the ACM SIG AI club at Purdue, now known as ML@Purdue. My most notable project was building a fully autonomous robot for the first VEX Robotics AI Competition. Purdue's VEX Robotics University team SIGBOTS is one of the best in the world and is the sister club to ACM SIG AI. I was asked to help demonstrate autonomous capabilities using edge computing devices and a novel sensor suite VEX Robotics was planning to release. **I was in direct contact with the Chief Technology Officer** of VEX Robotics' parent company, and led a team of 6 to build a modular perception and control stack other teams could use in later seasons of the competition. I personally developed algorithms for detecting and localizing game elements, and I supervised the development of a reinforcement learning model to control the robot. **I was the first author of our technical paper *Pac-Man Pete: An extensible framework for building AI in VEX Robotics***. My team and I open-sourced our code and released our technical paper for the greater VEX Robotics community after the season was over.

My involvement in the VEX Robotics AI Competition project drew the interest of an AI manager at Shield AI, a Series E startup that focuses on building autonomous pilots. I joined Shield AI as an AI Intern after my sophomore year and was amazed by the extraordinary talent in robotics and AI. It revitalized the same passion I had for robotics in high school. I was exposed to many new ideas about robotics agents, and **this inspired me to commit to pursuing applied AI research** and completely close off adjacent career paths such as software engineering. I developed a malleable end-to-end supervised ML pipeline that ingressed data from our pilot simulations. The pipeline was used to train pilot models. **I experimented with behavior cloning expert policies and ran experiments to distill knowledge from existing AI models in order to create foundational pilot models.**

Prior to returning to Purdue after my summer internship at Shield AI, I took a fall internship at Amazon as a Software Development Engineering Intern. I was placed on an Applied Science team, I had the privilege of crossing paths with an exceptional group of mentors which **allowed me to pursue an applied science project** instead of a traditional engineering one. While at Amazon I experimented with different approaches to extracting relevant information from unstructured health records and giving advice on preventative healthcare measures. I used a multitude of techniques from natural language processing and information retrieval to **build a recommender engine for preventative healthcare within a couple of months**. I delivered a final prototype to our Software Engineering team and gave a **demo to Amazon Health leadership, including our organization's Vice President**}.

During my internship at Amazon, I chanced upon an internal notification in the Amazon Science channels regarding the Alexa Prize Challenges. The TaskBot challenge interested me the most, as it aimed to develop a **multi-modal conversational agent designed to assist real-world users with tutorials**. Recognizing that this opportunity aligned perfectly with my interests, I reached out to various laboratories, eventually securing the commitment of the AKRaNLU Laboratory at Purdue to take on this project. I am the first author of our research proposal which **won $250,000** from Amazon Alexa. Within the nine month research challenge, my primary focus was **building natural language processing models**

with quick inference time for real-time use. On the science front, I was also involved in training profanity classifiers and aligning open-source large language models to domain-specific chats. On the engineering front, I continuously worked on UX improvements and bug fixes in our back end. Our team **advanced to the semi-finals** and achieved high ratings among real-world Amazon Alexa users. **We proudly published our paper titled *BoilerBot: A Reliable Task-Oriented Chatbot Enhanced with Large Language Models***.

When I returned to Purdue in the spring, I made the decision to leave the Duality Laboratory, since my academic interests didn't align with the lab's objectives. My search for a robotics-first laboratory where I could research interactive AI led me to join the CoRAL Laboratory in January 2023 to conduct independent studies, where I remain to this day. Within the CoRAL Laboratory, I've been engaged in two significant projects. One project involves **teaching robots how to infer objectives from ambiguous language prompts using operator eyesight in end-to-end ML models**. The second project uses **large language models and retrieval-augmented generation to develop a new method of navigating unseen environments using prior context**. Both of these projects are on track for publication by January 2024.

As the Alexa Prize Competition reached its conclusion my ex-Amazon manger extended an exciting opportunity to join a pioneering AI Team at Armada AI, a novel and well-funded startup specializing in edge-based autonomous applications. I've been working at Armada AI as a part-time AI Engineer since June 2023 with plans to join as a full-time AI Engineer after I graduate. My role involves independent work on the development of AI products that showcase the capabilities of our edge AI platform. I am currently **researching new methods of answering domain-specific questions on real-time video feeds**.

Future Goals: In my ongoing pursuit of a career advancing autonomous systems, my immediate goal is to pursue a Master's Degree in Computer Science or Artificial Intelligence. **I'd like to conduct research jointly with a university laboratory and industry, gaining valuable insights from academia while working on applied research that will impact real end-users.** This approach will enable me to further refine my mathematical, AI/ML, and computer science skills while making tangible contributions to the field.

My overarching goal is to design and develop intelligent systems that seamlessly collaborate with humans. I'm planning on joining the industry as an Applied Scientist or AI Research Engineer after graduating with a Master's Degree. Looking forward to the long-term future, I'm also interested in starting a company so I can have a greater impact beyond traditional employment.

Broader Impacts: My journey in bringing people together began with my involvement in the ACM SIG AI club during my freshman year, and culminating in my role as club president due to my deep passion for the subject.

During my time at Purdue I noticed that the university's fragmented computing departments stifle innovation and student collaboration. The club had structural limitations that were inadvertently unwelcoming to students and faculty outside the Department of CS. To address this issue, I founded ML@Purdue, which effectively united students from diverse backgrounds across the Polytechnic, ECE, and CS departments. The club's rapid growth, nearly tripling in size in a year year, signified its success as a unifying force.

My greatest non-technical achievement has been building ML@Purdue into a thriving hub for the AI community at Purdue, fostering a culture of collaboration and innovation. I am dedicated to uplifting the greater scientific community throughout the course of my career through mentorship and continuing to create spaces where individuals, irrespective of their background, can come together for meaningful social and academic activities. My ultimate goal is to connect motivated individuals to one another and build a more inclusive, collaborative, and impactful community.