Academic Statement of Purpose

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I grew up at Ataturk University where my father was a Professor at Medical School. I recall my early days, wandering through the university's vast library, gazing at the images within books even before I could read. It was here that I began to envision a future working at a university, where I could immerse myself in the world of books, explore various subjects, and share knowledge with others. I was a student who sought more than what they thought in class. By the time I reached my junior year in high school, I started learning software development and became an active member of international communities like Women Techmakers and Google Developer Groups (GDG). I also took on the role of organizing conferences on software development and inclusivity within the industry. This passion for learning led to my high school graduation with top honors and a remarkable achievement in the national university entrance exam, placing me in the top 0.1%. Having learned the basics of coding and loving problem-solving, I chose to pursue Computer Engineering major at Middle East Technical University (METU) which is known as Turkey's best university in teaching computer science theory.

I attended a variety of research labs during my undergraduate studies in an effort to find out the most suitable area for my Ph.D. studies rather than focusing on a specific topic. As a starting point, I contributed to developing a deep learning model as an undergraduate research assistant at Bilkent University UMRAM under the supervision of Prof. Tolga Cukur. I have implemented a Convolutional Neural Network and used the open-access ABIDE fMRI data to categorize autism spectrum disorder and typical control participants with a 93% accuracy. After completion of my junior year, I worked as a research assistant at Middle East Technical University, ImageLab, under the supervision of Dr. Hande Alemdar. Our project was ROBOtic Replicants for Optimizing the Yield by Augmenting Living Ecosystems" supported by the H2020 FET Open program. The goal of the project was to create a micro-robotic system that models the attendants of the queen bee to support the well-being of the colony. I contributed to this project by developing an object-tracking algorithm using OpenCV to track the "court bees". I also did an internship at V-Count Technology which is a company that offers demographic analysis for customer-involved companies for marketing purposes using their visual sensors located in shops. I contributed to their demographic classifier model's accuracy by increasing it by 4% using my previous Neural Network knowledge. This experience underscored the profound connection between advancements in scientific research and their practical applications in the industry.

Finishing my junior year I transferred to the University of Colorado, Boulder. The primary reason why I transferred is my interest in pursuing a Ph.D. and becoming a researcher. Even though the theoretical foundation classes taught me the core knowledge of computer science well, METU lacks a variety of distinguished elective classes. In addition, the research I was involved in was behind my expectations in terms of productivity and learning. Although transferring was a hard decision when I needed to leave my friends and family and my family's financial abilities were limited; my passion for computer science and my experience contributing to research projects have driven me to seek even more growth and development opportunities. Indeed, I found a variety of classes about my interests and decent research opportunities at CU Boulder, and I overcame the financial obstacles by working as a research assistant. Also, I performed well in class and earned a 4.0 GPA while working. I was selected as Tau Beta Pi, the Engineering Honor Society member at CU Boulder.

I was inspired by **Prof. Sriram Sankaranarayanan's** Advanced Data Structures class, which led me to join his research group in my first year at CU Boulder. I participated in the Artificial Pancreas project carried out by faculty at CU Boulder and the Barbara-Davis Center for Type-1 Diabetes at the CU Anschutz Medical Campus. The goal of our project is to build a better insulin pump, which works as a pancreas by supplying insulin to the bloodstream for energy. I tried to improve the pump such that it can combine data from any wearable sensors and mobile apps with survey data about habits and real-time glucose monitoring to assist in maintaining blood sugar under control. After trying several regression models such as Neural Networks we decided data is more complex than we expected as it can be explained by just one behavior and neural network models can learn patterns that are specific to training data. We came up with an idea of behavioral switches inside the data and we wanted to observe and identify those behavioral switches.

What excites me the most about this project is its universal applicability beyond just the Artificial Pancreas initiative. This research paves the way for mathematical modeling in various domains such as modeling of natural processes.

I wanted to apply this idea to a variety of areas and I contacted **Prof. Necmiye Ozay** at the University of Michigan, Ann Arbor, whose research area includes event detection and information extraction algorithms from data, to offer her to collaborate in our project with Prof. Sankaranarayanan. I got accepted as a visiting REU awarded by the National Science Foundation. The main goal of our research was to analyze the different behaviors of the drivers. Our solution offers autonomous car training simulations to incorporate realistic environments that include cars generated using models learned from real-life data. As a continuation of our work with Prof. Sankaranarayanan and Prof. Ozay, I decided to do a Senior Thesis under the supervision of **Prof. Sankaranarayanan**, on developing an efficient algorithm for identifying and predicting hybrid systems from data, with the key objective of limiting the number of models and switches. The work I have done is capable of identifying a minimum number of models that explain the switched systems with the minimum number of switches. We applied our algorithm to the artificial pancreas data set. I am working on developing prediction algorithms using generated models on newly introduced data sets while establishing an accurate and stable prediction model.

While working on this, I was accepted and fully funded as one of the two undergraduates to attend the Twelfth Summer School on Formal Techniques and Formal Methods in the Field (FMiTF) Bootcamp organized by Stanford Research Institute (SRI). The summer school concentrated on the principles and practice of formal techniques, with a strong emphasis on hands-on application and development. We learned validating formal models, first-order theorem proving, and automated reasoning. This summer school played an important role in my future research since I learned programming logic and how to experiment with Satisfiability Modulo Theories.

Experiencing different labs has improved me in the intersection of areas; modeling and verification of cyber-physical systems, machine learning, computational complexity theory, and system identification. Through taking graduate-level classes like Autonomous Systems and Advanced Data Structures, attending the Summer School of Formal Languages, and conducting research at Prof. Sankaranarayanan's lab I formed my knowledge in those areas. Also, I have taken my research one step further by collaborating with Prof. Ozay. I successfully included an application that drew the interest of an additional supervisor to join my research project. It was a profound experience working with two supervisors whose areas of research differ in terms of applications. Furthermore, I took a solid step towards learning how to conduct independent research since I led the research for nearly a year under the supervision of Prof. Sankaranarayanan. I managed our course of action, carefully considering the status of the results and my supervisors' suggestions at every step. I believe that this ability and the leadership to complete the proposed work are vital in doing fundamental and novel research.

I aim to contribute to the areas including verification, cyber-physical systems, and the development of reliable, effective program synthesis systems. I want to continue my graduate studies at the University of Michigan because it provides an opportunity to work with world-class faculty and learn from exceptional peers. There are faculty members who share similar research interests with me at the University of Michigan. In particular, **Prof. Jean-Baptiste Jeaninn's** research on the verification of cyber-physical systems greatly aligns with my previous research and interests as we discussed in a Zoom meeting. His recent study *Verified correctness, accuracy, and convergence of a stationary iterative linear solver: Jacobi method*, interests me as I am eager to work on formal verification and numerical methods. Also, **Prof. Xingyu Wang** who works on developing scalable, efficient, and reliable program synthesis techniques aligns with my interests. Specifically, I am interested in his recent study of *Interactive program synthesis by augmented examples* which I believe will be integral to my research interests.