Statement of Purpose

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In 2020, when the COVID-19 outbreak was at its peak, I along with some of my university peers came up with the idea of a relief activities coordination platform to assist numerous voluntary organizations in providing essential aid nationwide. Despite our dedicated efforts to launch the platform named Traan-Chitro, we encountered minimal interest from these organizations due to their concerns about data security and hesitance to adopt a new system. I was quite disheartened after this setback, but I never stopped thinking about why we failed. After some time, it became evident to me that our failure was not due to a lack of project potential, but rather stemmed from the oversight of conducting adequate research before initiating the idea. We overlooked assessing the targeted organizations' needs, their receptiveness to new systems, and their willingness to share data. That was the time when I learnt the critical importance of research, not just in understanding the technical aspects of software engineering and privacy, but also in acknowledging the pivotal role of human factors.

During my time at BUET, I developed a keen interest in software development and security. Engaging in challenging academic projects like creating 'E-luxurious'—a property rental platform like Airbnb—and designing a full-scale DNS flood attack with a corresponding defense mechanism heightened my skills. I also ventured into multiple outsourced projects to broaden my experience in software development practices. Later, I started participating in CTF competitions, where I learnt about various security tools. I especially loved solving reverse engineering problems and I found it amazing how much information can be recovered through this process. I came to know about this tool Ghidra, which is broadly used for software reverse engineering. I was fascinated by its decompilation capabilities. After graduation, I became a software engineer at IQVIA, specializing in C# .NET backend development. In this role, I extensively worked with various DBMS and software testing frameworks. I also focused on improving program analysis techniques to identify and resolve security vulnerabilities in developer-written code, ensuring compliance. These experiences allowed me to closely observe prevailing issues in the software industry, thus motivating me more to pursue a research career in which I can continue to delve further into software security. My ambition is to excel as a researcher specializing in **Security, Software Engineering,** and **AI**.

My journey into formal research began with my undergraduate thesis in computational criminology, where I developed a decision-aid system named 'Cri-Astrologer'. Its main purpose was to assist in the conduct of police investigations by predicting criminal demographic profiles using crime evidence data and victim demographics. With the guidance of my supervisor Dr. A. B. M. Alim Al Islam, I proposed a deep factorization machine based DNN architecture which outperformed existing machine learning and deep learning algorithms in predicting criminal demographics. It was published as a conference paper in **ACM NsysS'22**. At IQVIA, I have led research and development efforts to enhance database query performance, reduce query counts, and explore cost-efficient solutions. Currently, I am actively engaged in an R&D project at IQVIA aimed at revolutionizing user interactions with data visualization. The aim of this project is to simplify complex dashboard configurations by integrating large language models (LLMs) into the user interface. This approach will allow users to ask natural language queries and the LLM provides insights to automatically generated charts, delivering an exceptional user

experience. Throughout this project, I have explored various LLMs including GPT, Llama and Mistral, delving into prompt engineering and fine tuning these models. Working with LLMs in this project opened a new door of research interest for me: **Leveraging LLMs in solving software and security related problems**.

In pursuing my research interests encompassing **Security**, **Software Engineering**, and **Application of LLMs**, I want to combine the strengths of each field to enhance one another. In my doctoral research, I aim to conduct an extensive investigation into software stack vulnerabilities, particularly examining the multifaceted applications of LLMs within the domain of software security research. This includes investigating and identifying ways to utilize LLMs in detecting and mitigating software stack vulnerabilities. Additionally, I am keen on enhancing existing security tools, delving into different static and dynamic analysis methods to develop practical solutions that can benefit the wider community.

I consider Kahlert School of Computing at the University of Utah a suitable place to pursue my PhD, as there are several active researchers with whom I believe I will be able to contribute. Specifically, I am keen on collaborating with **Dr. Luis A. Garcia** in his project **Semantic Reverse Engineering of Cyber-physical Systems (Drones)**. This project aligns closely with my research interests, leveraging LLMs for reverse engineering tasks. If given the opportunity to contribute to this project, I intend to apply my experience in working with LLMs to tackle challenges in reverse engineering tasks. I want to explore both static and dynamic analysis techniques to find out existing vulnerabilities in the system. My interest also lies in vulnerabilities in the software stack, which can be found through methodologies like **fuzzing**. So, I am also interested to work with **Dr. Jun Xu** who shares similar research interests. I am particularly intrigued by his work titled "**Generation-based fuzzing? Don't build a new generator, reuse!**". The idea to reuse Domato and HTML to PDF converters as a PDF generator is interesting. As a future direction, I want to explore whether it will be possible to incorporate the ability of LLMs to make the generation more robust. I am also interested in the research work of **Dr. Stefan Nagy**. His work, **SieveFuzz** – a tripwiring-directed fuzzing tool piqued my interest. By reducing the search noise, it can perform much faster than other existing fuzzers. But it leaves some unexplored alternative paths which might contain bugs and remain unchecked. Given the chance, I want to expand on this work to increase the coverage of this tool. Additionally, I am also open and would be happy to work with others and explore the areas with similar focus.

My future goal is to become an accomplished academic, emphasizing both research and teaching while maintaining active connections with the industry. To achieve these goals, I am willing to explore new domains and embrace challenges that arise during my graduate studies. Please feel free to visit my portfolio at https://atiqur-rahman-0041.github.io/ for a detailed overview of my research, publications, and work experiences.