

Initial Research Essay

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1 Introduction

I was four when my father introduced me to the fascinating game of chess. I always used to admire my father as a great player. While playing and learning with him, I gained confidence in the game over time, but only because he used to let me win. However, it all changed when I was five. We bought our first desktop computer, and I played a game of chess against the computer. Of course, I lost poorly and was baffled how a machine could do something so complicated as playing chess and that too much better. Moreover, I was even more surprised when it crushed my father in the game. It was later, in the second year of my undergraduate studies, I studied Artificial Intelligence. I applied the concepts to build a Tic Tac Toe Android App from scratch, where one can play against the computer.

I have been curious and enthusiastic about computers since, and this motivated me to pursue my Master's in Computer Science. Throughout my undergraduate college degree, I have tried my best to obtain a broad array of experiences so that my graduate studies can build upon a strong foundation. I have worked in the industry, under a professor, and on personal research projects. I also acquired valuable leadership and communication skills by participating in many extra-curricular and volunteering activities. My diverse background and strong academic performance prepare me well for graduate studies.

I did my bachelor's in Computer Engineering from Savitribai Phule Pune University and during my final year I did an internship at Technogong which is marketing startup in Pune, Maharashtra. During this internship I and my other three teammates created an Android app using Java. We had to implement the same features which were being offered on the website counterpart of this application. We followed the Agile methodology for the software development process and had daily scrum meetings with the team and the senior software engineers of the company. We then used to discuss among ourselves and distribute the workload. We created the wire-frames and then took the approval from our project manager. Then we implemented the Apache server, MySQL database and the Java files for the app.

After my graduation I got placed at Acquia as an associate software engineer. I was assigned to the Marketing team and used to work on the Campaign Factory product. I got to learn a lot at this company from the on-boarding process and specially from the guidance of my seniors. We followed Agile methodologies for the software development process. The team used to have daily scrum meetings where it would discuss the work that is to be done today and report any issues found. We also used to communicate with the Quality Assurance team to test the code we have submitted. I used to pickup simple tickets at the start and used to take guidance from my seniors engineers on how to solve a specific problem. The manager was friendly and used to manage the team well. We had a guy who used to work in Boston and was the Technical lead on the product.

During my time at Acquia I learned a lot. I got well versed in Object Oriented programming concepts and gained deeper knowledge about the Laravel web framework. I also learned a lot about Kubernetes, Docker, and data base management using MySQL. My time at Acquia proved to be

quite beneficial to me as it made me grow and I too proved to be a great asset to the company as well. As I always completed my tickets on time with the test cases. And used to work on tickets that were in the future sprint.

Arriving in the U.S. was a dream come true and the Virginia Tech campus was breath-taking. On top of that I got a Graduate Assistant-ship at the Security and Identity Services team in the Information Technology department at Virginia Tech. My manager was the one who interviewed me and he was quite supportive and friendly as well. I told him that my interest lies in the Cyber-security domain which aligned with a role in the team.

My current work at Virginia Tech focuses on scanning the various web applications provided by the University to its students and employees. My goal is to automate these scans and fit it to the deployment pipeline. The Virginia Tech IT team uses Gitlab for software deployment and testing. So, I first started with the ZAP tool. This is open source DAST (Dynamics Application Security Testing) tool written in Java. I created a maven project to run the existing Selenium scripts to login to a given web app using an authorized user. Then with the help of Java classes the code takes the session and the cookies from this existing browser in which the user is logged in and gives them to ZAP. The software communicates with the ZAP local API to run the scans on the Virginia Tech web application as an authorized user. This project worked when the web application consisted of simple HTML5 code. But the scans failed to crawl and audit a Javascript heavy web application. Also we came to know that ZAP did not support HTTP 2.0 protocol, which was used by the applications.

We moved on to Burp Suite, which is DAST tool as well, but it is not open source like ZAP. Now my goal is to first manually scan the web applications using Burp Suite by creating a login script, which is used to login to the web app using the provided credentials and then run the scans. But the scans stop working when Burp Suite comes across some components which it does not support. And the web applications used by Virginia Tech all use two factor authentication to authorize a user and they use Duo services for this. Duo uses an Iframe component which is not supported by the Burp Suite software. Hence, I am communicating with the Burp Suite support team to overcome this hurdle and make the scans run on the web applications.

2 Research

I worked with Dr. Uday Thool who is a Maths professor at the Institute of Science college, Nagpur Maharashtra. We worked on a novel way to generate prime numbers up to a given number. He came up with this novel algorithm and I coded this algorithm using the python programming language. Prime numbers play a major role in number theory and cryptography. This paper presented a new algorithm to generate primes without performing any divisions. It is simple, efficient, fast and different from the sieve of Eratosthenes. The work also introduces novel sieve method to extract all primes less than or equal to $2N + 1$, which is significantly faster than the sieve of Eratosthenes method. To check whether the number is prime or not, it is sufficient to test its divisibility by all primes less than or equal to the square root of that number. We used the same principle to generate primes called farming of primes. For this, we used first N primes as our seeds and generated all primes less than the square of $(1 + N\text{th prime} \text{ or } 2 + N\text{th prime})$ accordingly, whether $N = 1$ or $N \geq 1$. We can generate a few extra primes by making use of first N primes. It guarantees at least four-times of result! For $N = 1$, we get 4 primes smaller than $(1 + 2)^2 = 9$. For $N = 2$, we will have nine primes smaller than 25.

There is always a quest for finding a novel, faster method for the generation of primes. Ancient Greek Mathematicians first extensively studied the Prime numbers and their properties. In 250

BC, the Greek Eratosthenes created an algorithm for extracting primes from the bed of first N natural numbers with tremendous speed. The Mersenne prime numbers $M_n = 2^N - 1$ are of great importance. By the year 2018, a total of 50 Mersenne primes are known. Rivest-Shamir-Adleman (RSA) algorithm is a cryptography algorithm, and prime numbers play a vital role in encryption and decryption of messages and the size of prime numbers used, dictate how secure the encryption will be. The product of two large prime numbers makes the encryption much harder to crack. Primes play a great role in number theory, cryptography, signal processing, and computational Mathematics. Testing of primality of large numbers is a challenging, time-consuming, and cumbersome job. In the computer science, the finding of primes is significant. There are several theories on prime, but the cost of computation of big prime numbers is enormous. There is no known formula to generate all the primes, though there are several algorithms to generate primes. Prime number generation algorithms are extensively worked on. Many of the researchers claim for the efficient generation of primes. The research work introduced a new technique that, if P_1, P_2, \dots, P_N are the first N known primes, then we can generate all primes less than either 32 or $P_N + 2^2$ according to the value of P_N is two or greater than two without performing any divisions.

I am attending a reading group meeting every week, hosted by Dr. Chris Brown. His research interest lies in the Software Engineering domain. I plan to work on my thesis with him preferably on a topic that is related to the software development and cybersecurity domains.

3 Aspiration

My goal is to work in the Information Technology industry and in five to ten years reach a higher management position. My current goal is to land an internship during the summer of 2022, which will hopefully lead to a full time role when I graduate in May 2023. I also want to complete my thesis preferably on a topic that is related to software development and cybersecurity.

I am working hard on assignments and test in the courses, so that I graduate with a good GPA. This is my second semester here in Virginia Tech and I got a good grade of 3.85 in my first semester. And I hope to graduate in Spring of 2023 preferably with a full-time IT job in hand.