Final Reflection on My 2022 Enrichment Experience
at the MIT BeaverWorks Summer Institute

By Jason Qin

Thanks to the Garwin Family Foundation, I had the wonderful opportunity to attend a four week intensive summer course on Quantum Software through the MIT Beaver Works Summer Institute. Throughout this program, I was able to learn quantum software basics with real world applications and work alongside amazing people from all over the world.

In the first two weeks of the program, I was able to learn the basics of quantum computing– qubits, superposition, entanglement, and quantum gates, which my experience with Linear Algebra earlier this summer with the Yale Summer Session program really prepared me for. We also explored basic quantum algorithms with real world applications, like Grover's Algorithm, Shor's Algorithm, and the Quantum Fourier Transform, which we were able to implement and explore in real time with quantum-based coding languages like Q# and Qiskit. Each day, there would be a lab project to explore the quantum topics learned that day, which I worked through with my group of three other students.

I really enjoyed the focus on collaboration in this course that allowed me to share my ideas and learn from those of others, which is what makes computing and problem solving fun for me. There is not just one way to solve a problem and I love being able to work with my peers on real world cutting-edge problems. For the final project, my group set up a Github repository that allowed for easy sharing of code and a more collaborative programming environment, similar to a real world computer science project. Outside of learning about quantum computing, the course had a Discord platform and Minecraft server (and even a developing Minecraft mod run by one of the TAs) for students to talk and relax.

Later on in the course, we were able to implement our quantum programs with real quantum computer simulations through IBM's cloud-based system using Qiskit, which I found super exciting. In addition, we learned the basics of error correction and resource estimation, necessary topics to test the viability of our quantum systems in the real world where the environment and noise can impact the efficiency and accuracy of the quantum computing system.

The final project of the course challenged teams to explore a real world quantum algorithm and implement it using the fundamentals of quantum software learned throughout the course. For this project, I had the wonderful chance to explore the Variational Quantum Eigensolver, an algorithm with both classical and quantum parts that can be used to calculate the ground state energy of a molecule with wide applications to medical chemistry and theoretical physics, with my group.

We began our research by looking through various articles and videos on the algorithm, but we quickly moved on to reading published papers. One of the biggest hurdles was just trying to parse the papers' notations and terminology, which we spent several days on. Being able to translate from mathematical notation and pseudo-code on the papers into actual code to be implemented on a quantum computer proved very challenging, but with persistence with my group and help from the course instructors, we were able to implement a version of the Variational Quantum Eigensolver and were able to run the algorithm on small cases like the Hydrogen molecule.

Throughout the course, there were also multiple professionals in the quantum computing field as guest lecturers, including multiple CEOs of quantum computing startups, researchers from MITRE, and professors from MIT. Through these talks, I learned a lot about the current state of quantum computers and future aspirations of the community, as well as how I can get involved in this new and exciting field. I also realized just how small and new the quantum software field is, especially when my group met one of the creators of a library we were using in our program.

Because of the MIT BWSI Quantum Software Course and the Garwin Family Foundation, I now have a new and profound interest in quantum software and hope to engage in this exciting field for the future. Quantum Software technology is developing at a rapid pace and I really hope to be able to use the fundamentals that I learned in this course in the real world. I am so grateful for this opportunity to continue pursuing my passions in STEM and getting to know all of these amazing people who share those similar passions!