Quantum Gate Synthesis – SQUANDER
- Report 1. -

Balázs Menkó
Supervisor: Péter Rakyta

Eötvös Loránd University

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1 Motivation

Last semester, I took a course titled *Classical and Quantum Optimization*, taught by Péter Rakyta. In this course, we studied the basics of quantum computing and optimization, but we did not have the opportunity to write code. Now, in this course, I have the chance to explore how quantum computing works on real machines.

2 Theoretical background

In quantum computing, calculations are performed using quantum bits, or qubits for short. Qubits leverage the principles of quantum mechanics, such as superposition and entanglement. These properties enable certain algorithms to achieve quadratic or even exponential speedup compared to classical methods.

The SQUANDER package[1] is an optimization-based quantum compiler [1]. It is built in C/C++ and also provides Python interfaces. Using this tool, quantum circuits can be decomposed.

3 Project plans

After my first meeting with my supervisor, I gained access to an SSH server where I can work. After installing the SQUANDER package, I was able to run some example codes.

In this semester-long project, I aim to learn how to use SQUANDER. For the next presentation event, I plan to run a built-in process with different optimizers and analyze how the cost function behaves. As a next step, I intend to apply gradient-free methods (e.g., the Powell method or the Nelder-Mead method) to compare their performance with gradient-based methods.

References

[1] Jakab Nádori, Gregory Morse, Zita Majnay-Takács, Zoltán Zimborás, and Péter Rakyta. *Line search strategy for navigating through barren plateaus in quantum circuit training*, 2024. 2402.05227

[1] See on GitHub: https://github.com/rakytap/sequential-quantum-gate-decomposer