



Qiskit Hackathon 2022
at
World of Quantum

JCKCJ

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Graduate Lecture **Quantum Adiabatic Optimization Algorithm**

SUMMARY

This lecture is developed during the Qiskit Hackathon at World of Quantum 2022. It is on the topic of Quantum Adiabatic Optimization Algorithm (QAOA).

The main target audience is master's students with preliminary background in quantum computing. Attendees of this lecture should be familiar with the basic concepts of linear algebra, quantum Hamiltonian, quantum circuit and optimization.

The organization of lecture materials is as follows: Concepts and theory will be presented as front lecture in PowerPoint format. A Jupyter notebook is made to supply with examples and small quiz problems for students to solve during the lecture, as well as homework problems for the student to complete after the lecture.

During the lecture, two screens will be opened in parallel, one on the left for the PowerPoint and the other on the right for the Jupyter notebook. The notebook will be filled with solutions to the examples and quiz problems step by step by the lecturer and provided to the students after the lecture.

Contents

1	Lecture Plan	1
2	Powerpoint Lecture	3
3	Example Notebook	3
4	Homework Notebook	3
5	References	3

1 Lecture Plan

The lecture consists of a PowerPoint presentation and a Jupyter notebook. The lecturer will present the general theoretic concepts in the PowerPoint and then shows on the notebook how these concepts are applied in the max-cut problem. In the notebook are small tasks, which the students should try to solve during the lecture.

Introduction and Motivation

PowerPoint presentation

- Duration: 5 Minutes
- Content: Explain what name QAOA stands for and present use cases

Jupyter notebook

- Duration: 5 Minutes
- Content: Explain the max-cut problem

Overview

PowerPoint presentation

- Duration: 2 Minutes
- Content: Explain the very general concept of the QAOA

Theoretical base for QAOA

PowerPoint presentation (5min)

- Duration: 10 Minutes
- Content: explain Adiabatic theorem and Trotterization and combine them to end up at the QAOA algorithm

Hamiltonian creation

PowerPoint presentation

- Duration: 10 Minutes
- Content: Explain how to come from a cost function to a hamiltonian and from there to gates

Jupyter notebook

- Duration: 10 Minutes
- Content: Transform the cost function from the max-cut to a hamiltonian and from there to a gate

Circuit creation**PowerPoint presentation**

- Duration: 2 Minutes
- Content: Show how the quantum circuit is constructed

Jupyter notebook

- Duration: 10 Minutes
- Content: Construct the circuit for the max-cut problem and measure it

Recall and Outlook**PowerPoint presentation**

- Duration: 5 Minutes
- Content: Come back to the "Overview" graphic and summarize results, discuss Potential of QAOA

Homework task**Additional Jupyter notebook for homework**

- Task: Try to solve the max cut problem presented in the "TakehomeProblem" jupyter notebook at home. You can orientate using the jupyter notebook discussed during the lecture

2 Powerpoint Lecture

The powerpoint lecture should give the most important aspects to the topic, as well as a visual approach for a better understanding of the QAOA concept.

3 Example Notebook

The lecture notebook is intended to be shown during the lecture to provide an example for the theoretic concepts explained in the Powerpoint lecture and offers some examples, that the students can try hands-on in the lecture.

4 Homework Notebook

The students should work on the following notebook after the lecture. It contains a more complex exercise in the style of the Jupyter notebook that was presentet during the lecture.

5 References

- <https://qiskit.org/textbook/ch-applications/qaoa.html> (27.02.2022)
- <https://www.youtube.com/watch?v=AOKM9BkweVU> (26.02.2022)