

Quantum Algorithm for Max Cut

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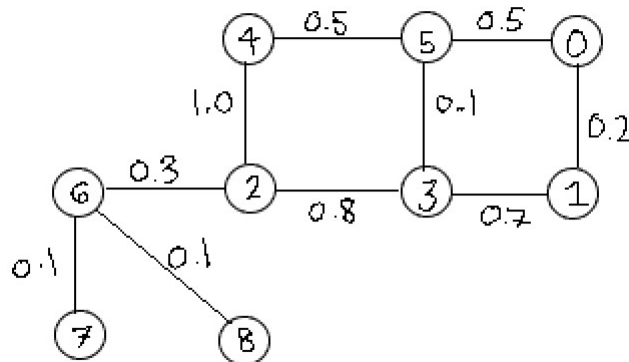
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Abstract

In this problem, you will attempt to find the max cut for a weighted graph. You must translate the graph to code and then select a quantum algorithm to provide your solution.

1 Problem

Given the graph, G. Use a quantum algorithm of your choice to find the maximum cut.



Hints:

1. Define your weighted graph as an array
2. Define QAOA circuit (cost unitary, mixing unitary, problem unitary, initial state)
3. Run QAOA circuit several times with your graph, aka "shots"
4. Cost function
5. Plot a histogram to visualize your solution
6. Analyze the output to determine your solution

2 Motivation

2.1 Weighted Max Cut

Definition. A **graph** is a mathematical object characterized by a set V of vertices (or nodes) that we can enumerate with integers $V = 0, 1, 2, \dots, n - 1$ and a set E of edges (pairs of nodes) which can be defined as $E = \{(a_0, b_0), (a_2, b_1), \dots, (a_m, b_m)\}$, where $a_j \neq b_j$ and $a_j, b_j \in V \forall j$.

Definition. The **weighted graph** is an edge-weighted graph, that is a graph where edges have weights or values.

Definition. Given a graph, G , a **max cut** is a cut whose size is at least the size of any other cut. That is, it is a partition of the graph's vertices into two complementary sets S and T , such that the number of edges between S and T is as large as possible.

2.2 Quantum Algorithm

Though I recommend QAOA (see qiskit textbook: <https://qiskit.org/textbook/ch-applications/qaoa.html>) you are welcome to use a different algorithm. However you must explain what algorithm you used instead and why. In your report, please explain each step of your circuit.

2.3 Accessing and Running on the IBM Quantum Computer

You may run your solution on IBM's quantum computing by making an account on IBM Quantum lab. See here: <https://quantum-computing.ibm.com/lab/docs/iql/first-circuit>.

3 Expected Result

1. Turn the given graph into a readable formate for your algorithm
2. Create the QAOA circuit
3. Run your result on your local machine (simulator).
4. Run your solution on the IBM quantum computer
5. Analyze the result provided to you to determine the max cut
6. Write your report
7. Upload your solution and final report to git

4 Rules

1. We are allowed to search the web to learn about QAOA, max cut, qiskit, and more, however you must cite these sources.
2. You must explain your code, i.e. you cannot copy and paste

5 Recommended Resources

QAOA: <https://qiskit.org/textbook/ch-applications/qaoa.html>

Max Cut https://qiskit.org/documentation/optimization/tutorials/06_examples_max_cut_and_tsp.html