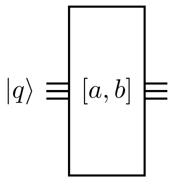
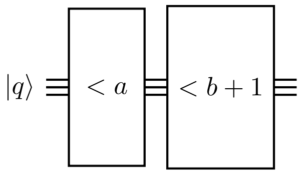
Documentation of Implementation A

Documentation for implementing the oracle ‘Interval $[a, b]$’ using the implementation A (previously described).

Oracle as Black Box



Oracle as its components



Unitary Matrix of Oracle

$$\begin{pmatrix} 1 & & & & & & \\ & \ddots & & & & 0 & \\ & & -1 & & & & \\ & & & \ddots & & & \\ & & & & -1 & & \\ & 0 & & & & \ddots & \\ & & & & & & 1 \end{pmatrix}$$

Reasoning behind the oracle algorithm

This oracle reuses the less-than oracle. It applies them twice to give a π-phase to the desired states and give a 2π-phase (return to initial state) to other ones. Firstly it applies the oracle ‘less-than a’, and then the oracle ‘less-than $b + 1$’, marking all the states in the interval $[a, b]$.

Classical algorithm which builds the oracle

Parameters needed for the classical algorithm which builds the oracle.

Parameters of the function:

- a: Lower boundary of the range of integers.
- b: Upper boundary of the range of integers.
- n: Number of qubits.

Parameters of the oracle:

- Which qubits of the general circuit is the oracle applied to.

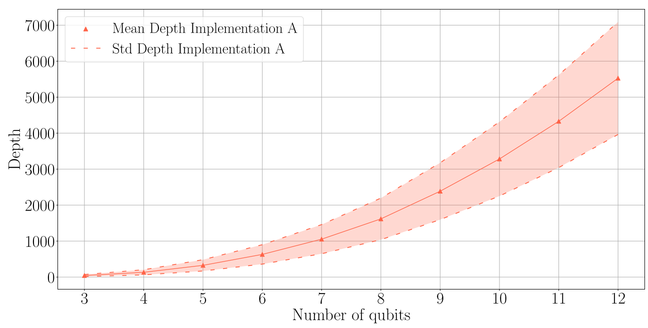
Conditions:

- Precondition: There are no hard preconditions on the states.
- Postcondition: Input state with a π-phase applied to states within range $[a, b]$.

Oracle Circuit

The details in this section are given with respect to a specific backend. In this case, FakeWashingtonV2 from Qiskit.

Depth:



Gate Set:

- The oracle requires a universal gate set (Clifford and T gates).
- The backend FackeWashingtonV2 has the following gate set: CX, RZ, S, X.

Assumptions over connections:

- The oracle assumes that each qubit is connected to the rest of the qubits.