Implementation in Quantum Simulator

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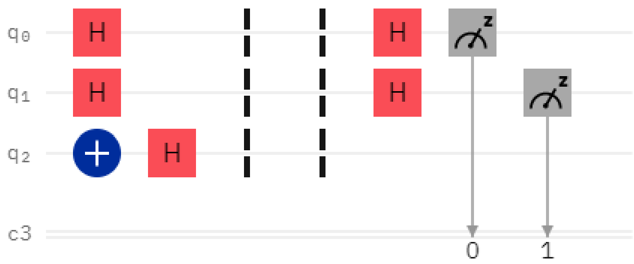
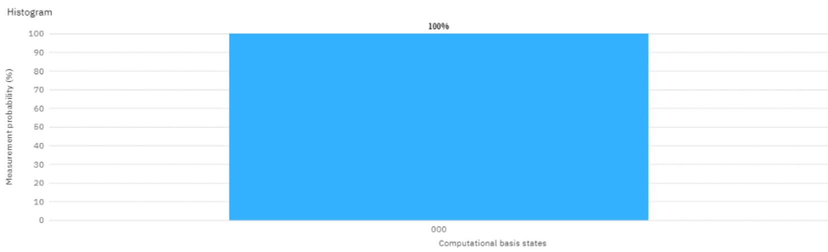
- **<u>Deutsch-Jozsa Algorithm:</u>**

  Here initially the oracle function is: $f(x, y) = (0, 0)\ \forall x$
  Circuit:

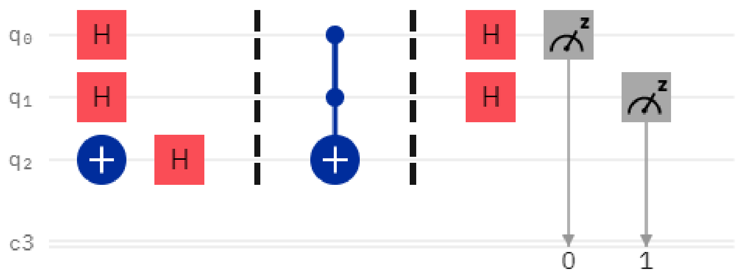


Histogram:

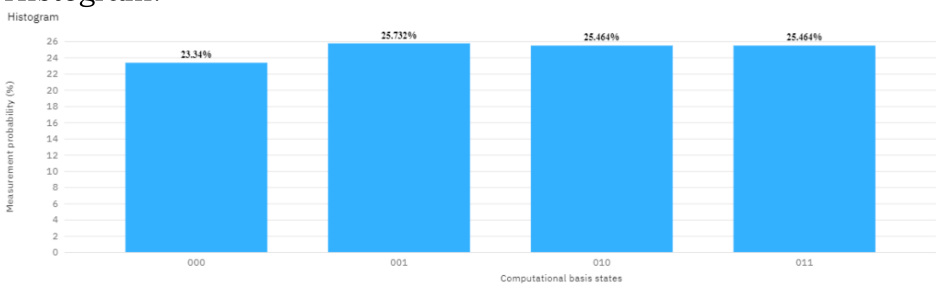


Here the circuit measured the 000 bit with probability 1. Hence, it's a **constant function.**

Here the oracle function is: $f(x, y) = (x \wedge y)$
Circuit:



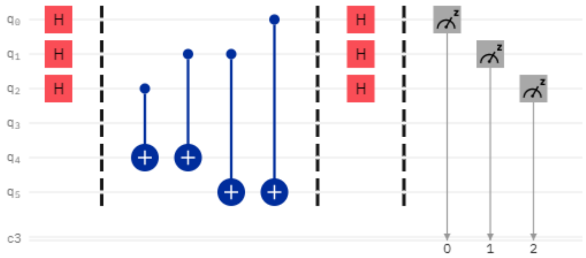
Histogram:



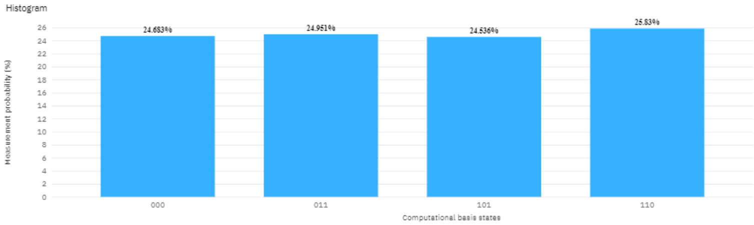
Here, the probability of 000 is 0. Hence, it's a **balanced function.**

- ## **Simon's Algorithm:**

Here the oracle function is, $f(x, y, z) = (0, y \oplus z, x \oplus y)$
Circuit:



Histogram:



Suppose, our target string is, $s = (s_0, s_1, s_2)$. Here, the measurement bits are 000, 101, 110, 011. So, s will be the solution of the equation,

$$x.1 \oplus y.1 \oplus z.0 = 0$$
$$x.0 \oplus y.1 \oplus z.1 = 0$$
$$x.1 \oplus y.0 \oplus z.1 = 0$$

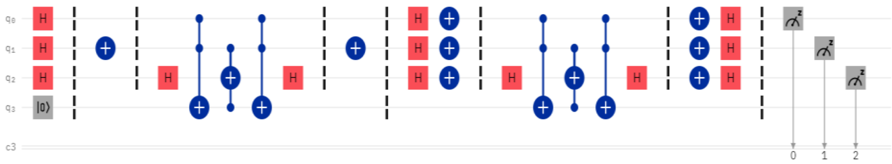
Solving these one may get that $s = (111)_2$.

- ## **Grover's Algorithm:**

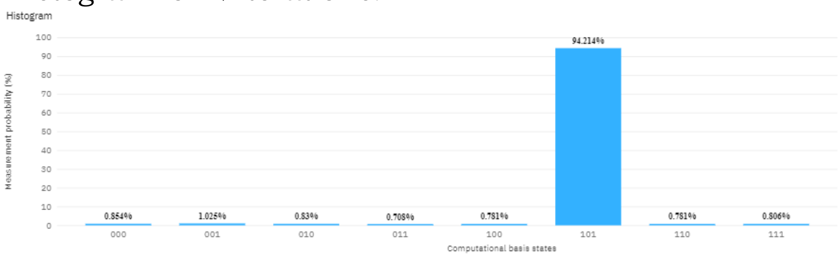
Let us consider the Boolean function, $f(x) = \begin{cases} 1, & if\ x = (101)_2 \\ 0, & otherwise \end{cases}$

Now let us define the corresponding oracle function $Z_f|x\rangle = \begin{cases} -|x\rangle, & if\ f(x) = 1 \\ |x\rangle, & otherwise \end{cases}$

Circuit:



Now, here N=2^3; i.e., $\frac{\pi}{4}\sqrt{N} = 2.22$. Hence, no. of steps reqd. to find the exact match is 2.
Histogram for 2 iterations:



Here, we can see that the probability at $(101)_2$ is very high than the others. So, from the histogram itself it's clear that it is far better than the classical computer. Where classical computer requires 8 many steps to find the match in the worst case, here 2 steps is enough.