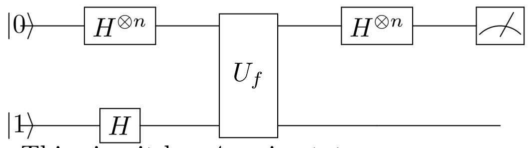
1 Introduction

The Quantum parallelism is a way to apply a function at different states of qbits in the same time, so now we can transform a complexity of $O(n^k)$ to $O(1)$. This complexity is the number of mesures of the function.

The Deutch-Jozsa algorithm is a more general version of the Deutch algorithm.

2 Circuit



This circuit has 4 main states:

$$\begin{cases} |\psi_0\rangle & \text{Is the beginning state} \\ |\psi_1\rangle & \text{Is the state after the first layer of H gates} \\ |\psi_2\rangle & \text{Is the state after the oracle U gate} \\ |\psi_3\rangle & \text{Is the state after the second layer of H gates} \end{cases} \tag{1}$$

3 Calculation

Starting state

$$|\psi_0\rangle = |0\rangle^{\otimes n}|1\rangle \tag{2}$$

Applying the first layer of H gates

$$\begin{aligned} |\psi_1\rangle &= H|\psi_0\rangle \\ &= H|0\rangle^{\otimes n}H|1\rangle \\ H|0\rangle &= \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle) = |+\rangle \\ H|1\rangle &= \frac{1}{\sqrt{2}}(|0\rangle - |1\rangle) = |-\rangle \\ \Longrightarrow |\psi_1\rangle &= \sum_{i=1}^{i=n}(|+\rangle)|-\rangle \end{aligned} \tag{3}$$

Applying the U oracle gate

$$
\begin{aligned}
|\psi_2\rangle &= U|\psi_1\rangle \\
&= U\sum_{i=1}^{i=n}(|+\rangle)|-\rangle \\
&= \sum_{i=1}^{i=n}(|+\rangle)|-\oplus f(+)\rangle
\end{aligned}
\tag{4}
$$