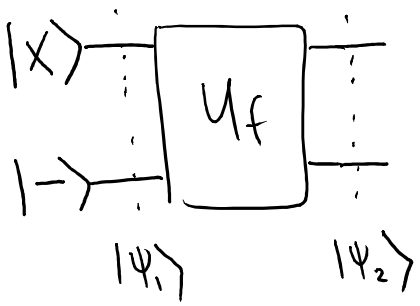
S. KIMMEL

- Crowd Notes
- Google vs IBM

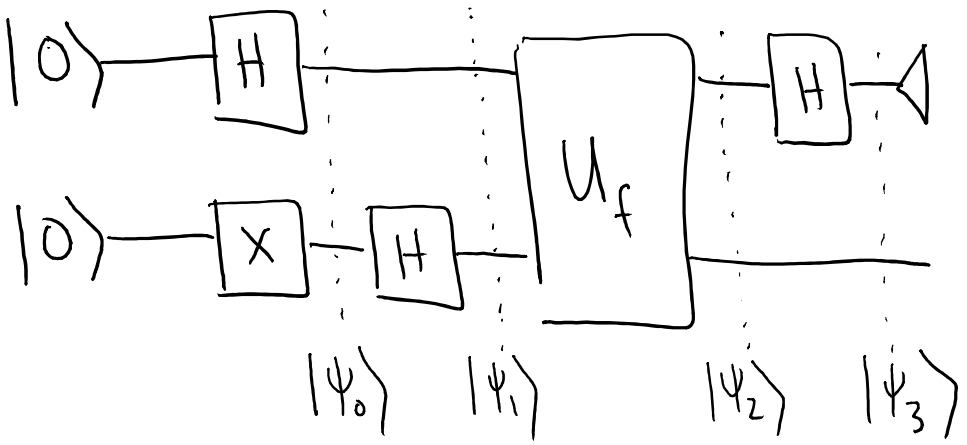


We analyzed this circuit last week. We showed

$$U_f|0\rangle|-\rangle = (-1)^{f(0)}|0\rangle|-\rangle$$
$$U_f|1\rangle|-\rangle = (-1)^{f(0)}|1\rangle|-\rangle$$

Phase Kickback

Now analyze: Use this result



Explain why output shows whether f is even or balanced?

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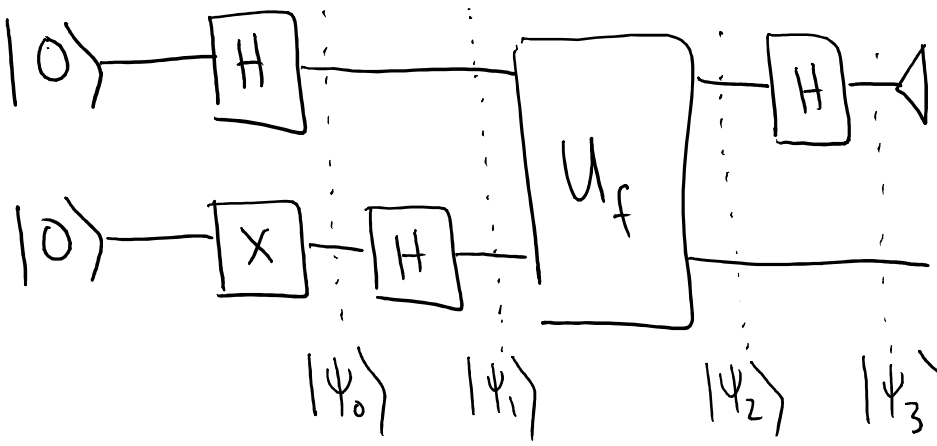

Deutsch Algorithm

$$|\psi_1\rangle = |+\rangle|-\rangle = \frac{1}{\sqrt{2}}|0\rangle|-\rangle + \frac{1}{\sqrt{2}}|1\rangle|-\rangle$$

$$|\psi_2\rangle = U_f \frac{1}{\sqrt{2}}|0\rangle|-\rangle + \frac{1}{\sqrt{2}} U_f |1\rangle|-\rangle$$

$$= \frac{1}{\sqrt{2}}(-1)^{f(0)}|0\rangle|-\rangle + \frac{1}{\sqrt{2}}(-1)^{f(1)}|1\rangle|-\rangle$$

↓ Phase Kickback

- If $f(0) = f(1)$

$$= (-1)^{f(0)}|+\rangle|-\rangle$$

↓

$$|\psi_3\rangle = |0\rangle|-\rangle$$

- If $f(0) \neq f(1)$

$$= (-1)^{f(0)}|-\rangle|-\rangle$$

↓

$$|\psi_3\rangle = |1\rangle|-\rangle$$

Measure in $\{|0\rangle, |1\rangle\}$ basis. Get $|0\rangle$ if even
Get $|1\rangle$ if balanced !

1 Quantum Query!