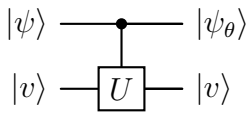
Quantum Computing cheatsheet

2024-09-10 by Naglis Šuliokas

1. Basics:

   $|0\rangle = \begin{bmatrix}1\\0\end{bmatrix}$, $|1\rangle = \begin{bmatrix}0\\1\end{bmatrix}$, $|\pm\rangle = \frac{1}{\sqrt{2}}(|0\rangle \pm |1\rangle)$, $iY = ZX$

2. Phase kickback

   $U|v\rangle = e^{i\theta}|v\rangle$
   ψ is in superposition

3. Superdense coding

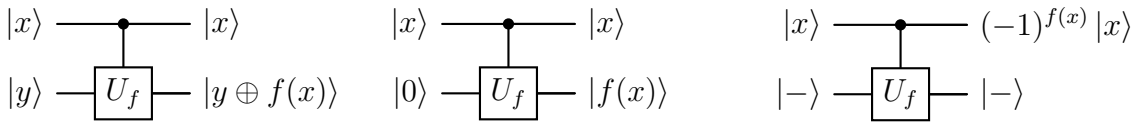
   $|\Phi^+\rangle = \text{CNOT}\,(H \otimes I)\,|0\rangle \otimes |0\rangle = \frac{1}{\sqrt{2}}(|00\rangle + |11\rangle)$, encodes 00

   $|\Phi^-\rangle = (Z \otimes I)\,|\Phi^+\rangle = \frac{1}{\sqrt{2}}(|00\rangle - |11\rangle)$, encodes 01

   $|\Psi^+\rangle = (X \otimes I)\,|\Phi^+\rangle = \frac{1}{\sqrt{2}}(|01\rangle + |10\rangle)$, encodes 10

   $|\Psi^-\rangle = (iY \otimes I)\,|\Phi^+\rangle = \frac{1}{\sqrt{2}}(|01\rangle - |10\rangle)$, encodes 11

4. Oracles

5. Deutsch's algorithm

6. Deutsch-Jozsa algorithm

   $$H^{\otimes n}|0\rangle^{\otimes n} = \frac{1}{\sqrt{2^n}} \sum_{x \in \{0,1\}^n} |x\rangle$$

   $$H^{\otimes n}|x\rangle = \frac{1}{\sqrt{2^n}} \sum_{z \in \{0,1\}^n} (-1)^{x \cdot z}|z\rangle$$

References:

1. Quantum Soar on YouTube.

2. Nielsen, M. A., & Chuang, I. L. (2001). Quantum computation and quantum information (Vol. 2). Cambridge: Cambridge university press.