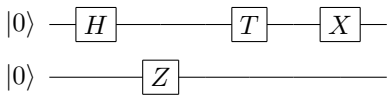
1 Normalization, relative phases, outcome probabilities

1. Normalize these vectors
   - $(4+3i)\,|0\rangle + \frac{e^{-i\pi/8}}{\sqrt{2}}\,|1\rangle$
   - $2^3\,|0\rangle - i\,|1\rangle$
2. Calculate relative phases
3. Calculate outcome probabilities

2 Tensor products

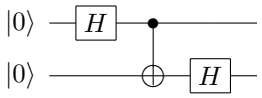
- $|0\rangle \otimes \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle) =$
- $\left(\frac{1}{\sqrt{3}}\,|0\rangle + e^{i\pi/4}\sqrt{\frac{2}{3}}\,|1\rangle\right) \otimes \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle) =$
- $H \otimes I =$
- $Z \otimes X =$
- $X \otimes H =$

3 Simple circuit



1. What is the overall state of both qubits?
2. Is it a product or entangled state?

4 Circuit with CNOT



- What is the overall state?
- How does it differ when the CNOT gate is omitted?

5 Gate definitions

$$Z = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$$

$$X = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$$

$$T = \begin{pmatrix} 1 & 0 \\ 0 & e^{i\pi/4} \end{pmatrix}$$

$$H = \frac{1}{\sqrt{2}} \begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$$

$$CNOT = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{pmatrix}$$