Tutorial 1 Numerical Solution

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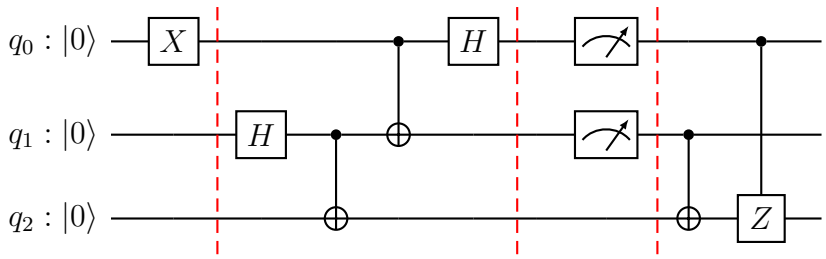

$$|000\rangle \xrightarrow{X \otimes I \otimes I} |100\rangle \xrightarrow{I \otimes H \otimes I} \frac{1}{\sqrt{2}} |1\rangle \left(|0\rangle + |1\rangle \right) |0\rangle$$

$$\frac{\left(|100\rangle + |110\rangle \right)}{\sqrt{2}} \xrightarrow{I \otimes CNOT} \frac{\left(|100\rangle + |111\rangle \right)}{\sqrt{2}} \xrightarrow{CNOT \otimes I} \frac{\left(|110\rangle + |101\rangle \right)}{\sqrt{2}}$$

$$\frac{\left(|110\rangle + |101\rangle \right)}{\sqrt{2}} \xrightarrow{H \otimes I \otimes I} \frac{\left(|0\rangle - |1\rangle \right)}{\sqrt{2}} \frac{|10\rangle}{\sqrt{2}} + \frac{\left(|0\rangle - |1\rangle \right)}{\sqrt{2}} \frac{|01\rangle}{\sqrt{2}}$$

$$\frac{|010\rangle}{2} - \frac{|110\rangle}{2} + \frac{|001\rangle}{2} - \frac{|101\rangle}{2} \qquad \textbf{(A)}$$

Measuring q_0 can lead to 0 or 1:

Case $q_{0,0}$: $\frac{|010\rangle}{2} + \frac{|001\rangle}{2}$ Case $q_{0,1}$: $-\frac{|110\rangle}{2} - \frac{|101\rangle}{2}$

Proceeding with Case $q_{0,0}$ and performing measure on q_1:

Case $q_{1,0}$: $\frac{|001\rangle}{2} \xrightarrow{I \otimes CNOT} \frac{|001\rangle}{2} \xrightarrow{I \otimes I \otimes Z} \frac{|001\rangle}{2}$

Case $q_{1,1}$: $\frac{|010\rangle}{2} \xrightarrow{I \otimes CNOT} \frac{|011\rangle}{2} \xrightarrow{I \otimes I \otimes Z} \frac{|011\rangle}{2}$

Proceeding with Case $q_{0,1}$ and performing measure on q_1:

Case $q_{1,0}$: $-\frac{|101\rangle}{2} \xrightarrow{I \otimes CNOT} -\frac{|101\rangle}{2} \xrightarrow{I \otimes I \otimes Z} \frac{|101\rangle}{2}$

Case $q_{1,1}$: $\frac{|110\rangle}{2} \xrightarrow{I \otimes CNOT} \frac{|111\rangle}{2} \xrightarrow{I \otimes I \otimes Z} \frac{|111\rangle}{2}$