QC14

Wednesday, March 24, 2021 4:44 PM

Are There Universal Quantum Gates

– In classical Computing – Universal Gates

NAND, Toffolli, Fredkin

fan-out

– for n → inputs 2^n – gates – for Classical Computers

– In Quantum Computing

– Finite collection of Gates

– Satisfies your requirements

– Your Requirements

– construct Gates

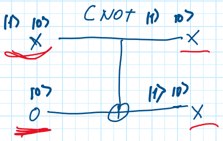
⇒ No Cloning Theorem.

most simple

– Classical Computing – Fan – out

not reversible

CNOT



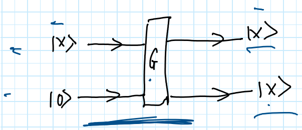
→ $|0\rangle, |1\rangle$

superposition Inputs

– No cloning theorem

Cloning ≡ Fan Out

G – it can Clone



not possible.

If Cloning Exist we should get

Cloning Conditions

1. $\hat{G}(|0\rangle|0\rangle) = |0\rangle|0\rangle$

2. $\hat{G}(|1\rangle,|0\rangle) = |1\rangle|1\rangle$

3. $\hat{G}\Big(\underbrace{\big(\tfrac{1}{\sqrt2}|0\rangle+\tfrac{1}{\sqrt2}|1\rangle\big)}_{1},\underbrace{|0\rangle}_{2}\Big) = \left(\tfrac{1}{\sqrt2}|0\rangle+\tfrac{1}{\sqrt2}|1\rangle\right)\left(\tfrac{1}{\sqrt2}|0\rangle+\tfrac{1}{\sqrt2}|1\rangle\right) = \tfrac12|0\rangle|0\rangle+\tfrac12|0\rangle|1\rangle+\tfrac12|10\rangle+\tfrac12|11\rangle$

1) $\hat{G}|00\rangle = |00\rangle$

2) $\hat{G}(|10\rangle = |11\rangle$

3) $\hat{G}\Big(\underbrace{\tfrac{1}{\sqrt2}|00\rangle+\tfrac{1}{\sqrt2}|10\rangle}\Big) = \tfrac12\big(|00\rangle+|01\rangle+|10\rangle+|11\rangle\big)$

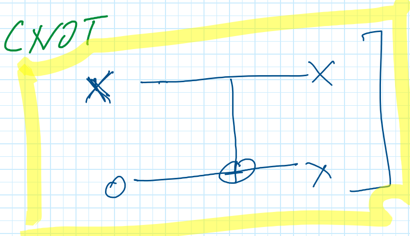
Linear $\hat{G}\frac{1}{\sqrt{2}}|00\rangle + \hat{G}\frac{1}{\sqrt{2}}|10\rangle = \frac{1}{\sqrt{2}}\hat{G}|00\rangle + \frac{1}{\sqrt{2}}G|10\rangle = \frac{1}{\sqrt{2}}|00\rangle + \frac{1}{\sqrt{2}}|11\rangle$

$$\frac{1}{\sqrt{2}}|00\rangle + \frac{1}{\sqrt{2}}|11\rangle \neq \frac{1}{2}\left(|00\rangle + |01\rangle + |10\rangle + |11\rangle\right)$$

There is NO G gate

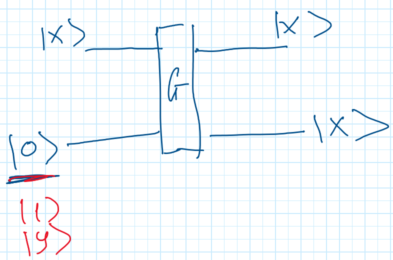
⟹ Classical Computing

CNOT



Used for copying Procedure.

⟹ Quantum Computing



No such Gates

⟹ No Copying in quantum Computer.

⟹ If we use $\boxed{|0\rangle}$ $\boxed{|1\rangle}$ Basis qubit

Logically they are identical to Classical Computers

⟹ New stuff comes when

$$\frac{\frac{1}{\sqrt{2}}|0\rangle + \frac{1}{\sqrt{2}}|1\rangle}{\frac{1}{}|0\rangle \quad \frac{1}{}|1\rangle}$$

$\sqrt{2}\,|0\rangle - \sqrt{2}\,|1\rangle$

$$|\psi\rangle = a|0\rangle + b|1\rangle$$

$$a^2 + b^2 = 1$$

infinite number of qubits.