

Quantum Computing: using Qiskit

Binary Operations: A quick review

0, 1, 2, ... 10 base

0, 1 2 base

$$9214 = 9 \times 10^3 + 2 \times 10^2 + 1 \times 10^1 + 4 \times 10^0$$

$$1001 = 1 \times 2^3 + 0 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$$
$$= (9)_{10}$$

Addition in binary

$$\begin{array}{r} 11100 \\ + 01010 \\ \hline 100110 \end{array}$$

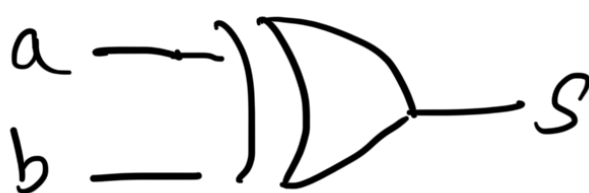
Truth table

C = Carry
S = Sum

a	b	C	S
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

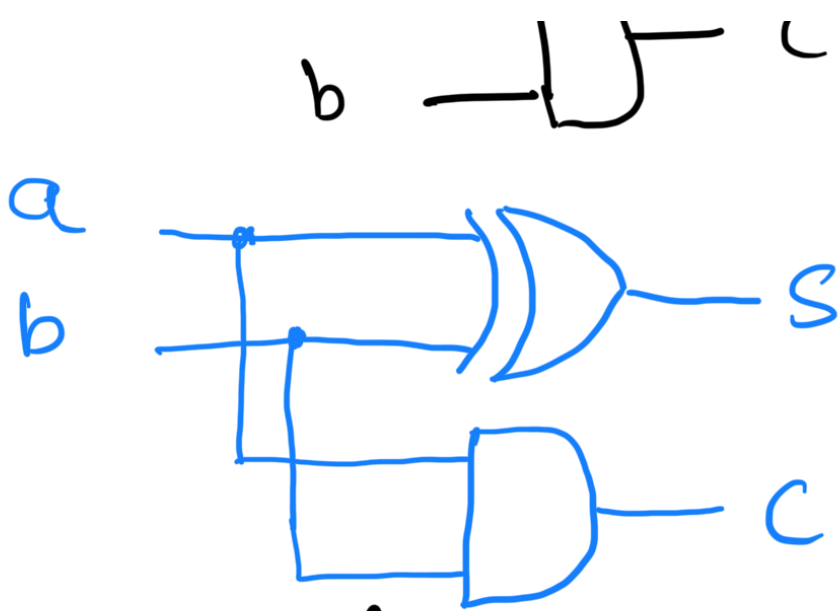
Half
adder

XOR



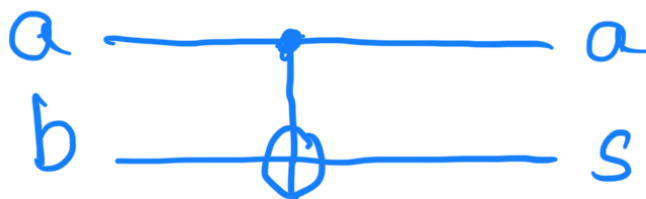
AND



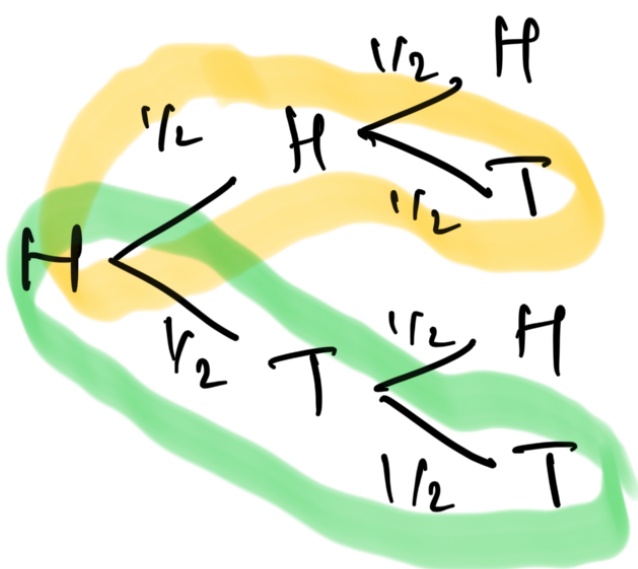
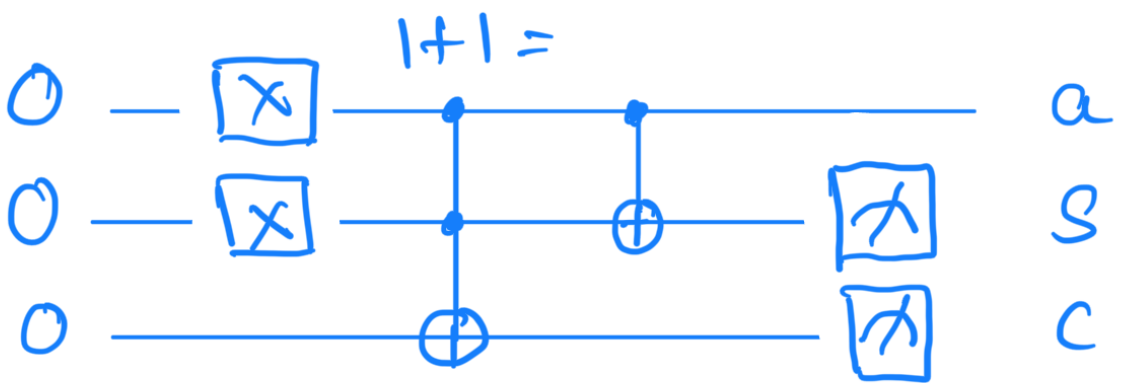
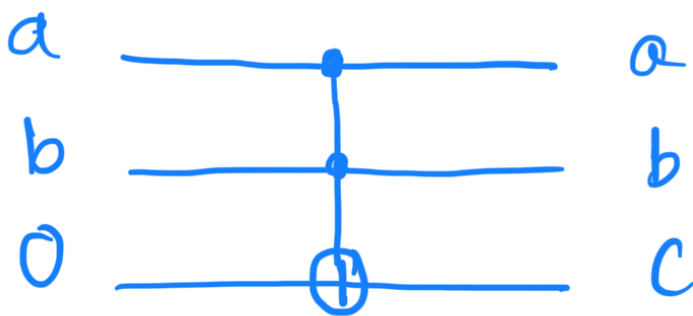


Boolean logic gate

CNOT (CX)



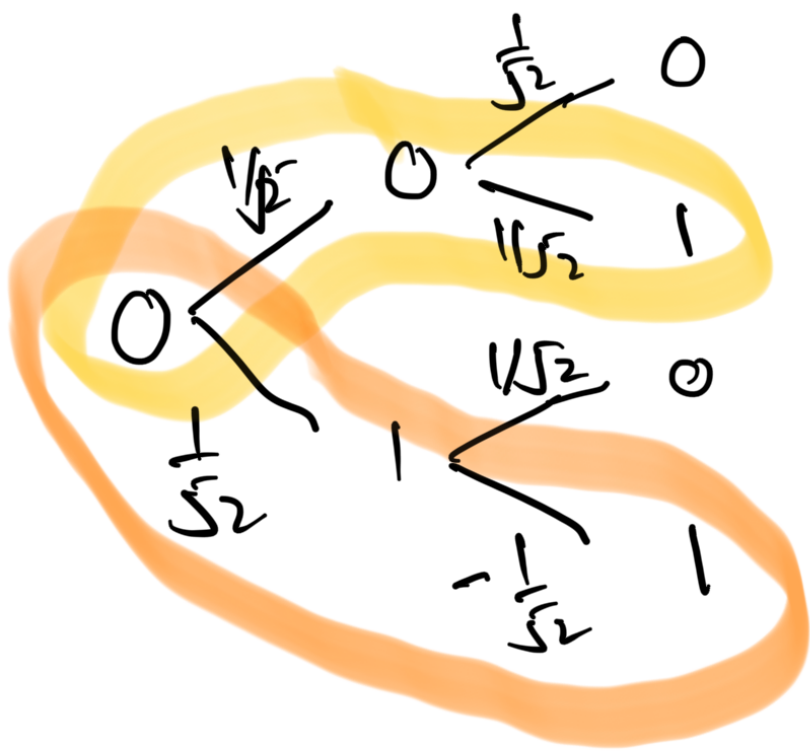
Toffoli



$$\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

$$\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

$$\frac{1}{4} + \frac{1}{4} = \frac{1}{2}$$



$$\frac{1}{\sqrt{2}} \wedge \frac{1}{\sqrt{2}} = \frac{1}{2}$$

$$\frac{1}{2} + \frac{1}{2} = 0$$

$$\frac{1}{\sqrt{2}} \wedge -\frac{1}{\sqrt{2}} = -\frac{1}{2}$$