Quantum Computing Basics

Here is where your presentation begins

Dirac Notation

$$| v \rangle = \begin{pmatrix} v_1 \\ v_2 \\ \cdot \\ \cdot \\ \cdot \\ v_N \end{pmatrix}$$

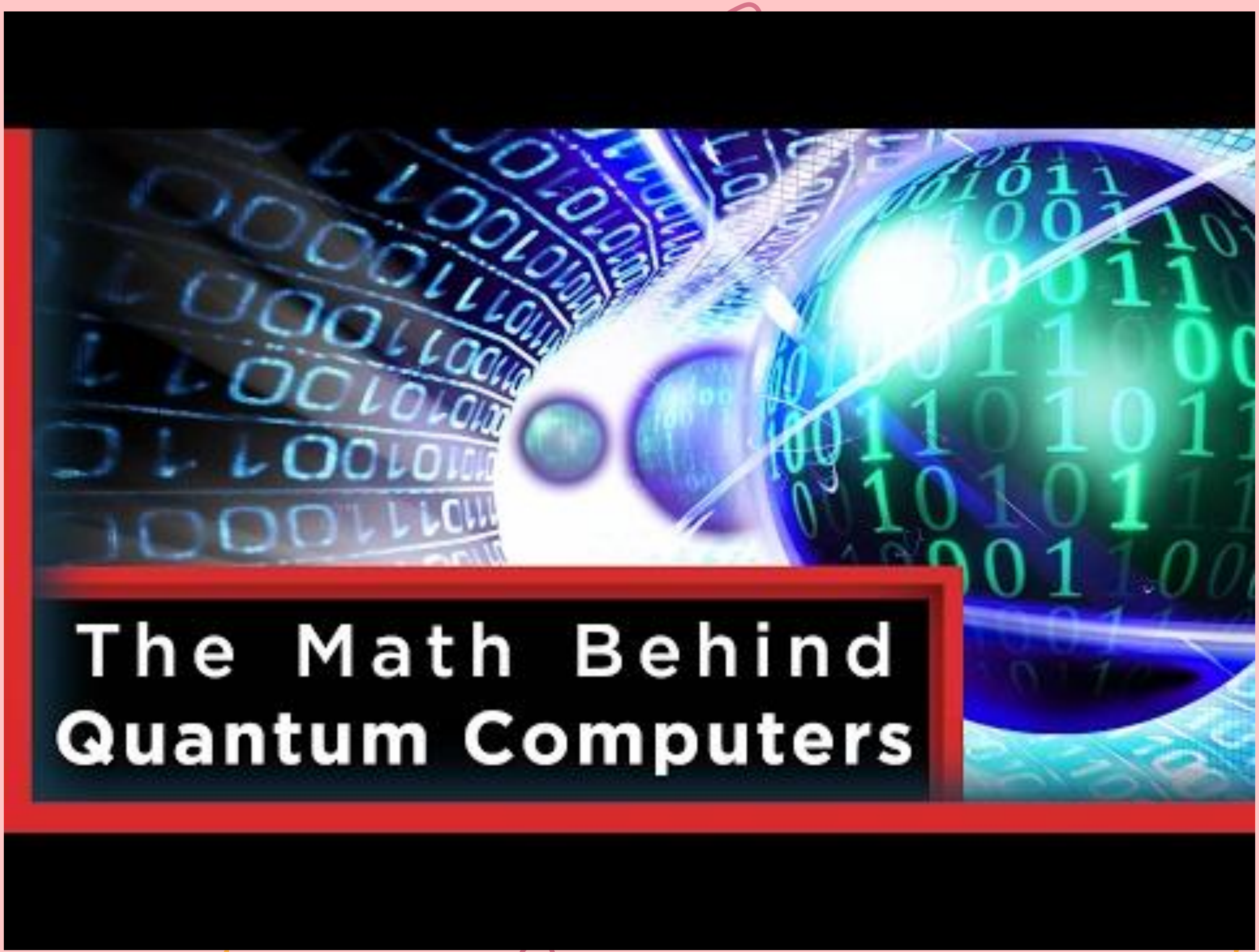
$$|10\rangle = \begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \end{bmatrix}, \text{ and } |11\rangle = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}.$$

$$\text{length}\left(\begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix}\right) = \sqrt{a^2+b^2+c^2+d^2}$$

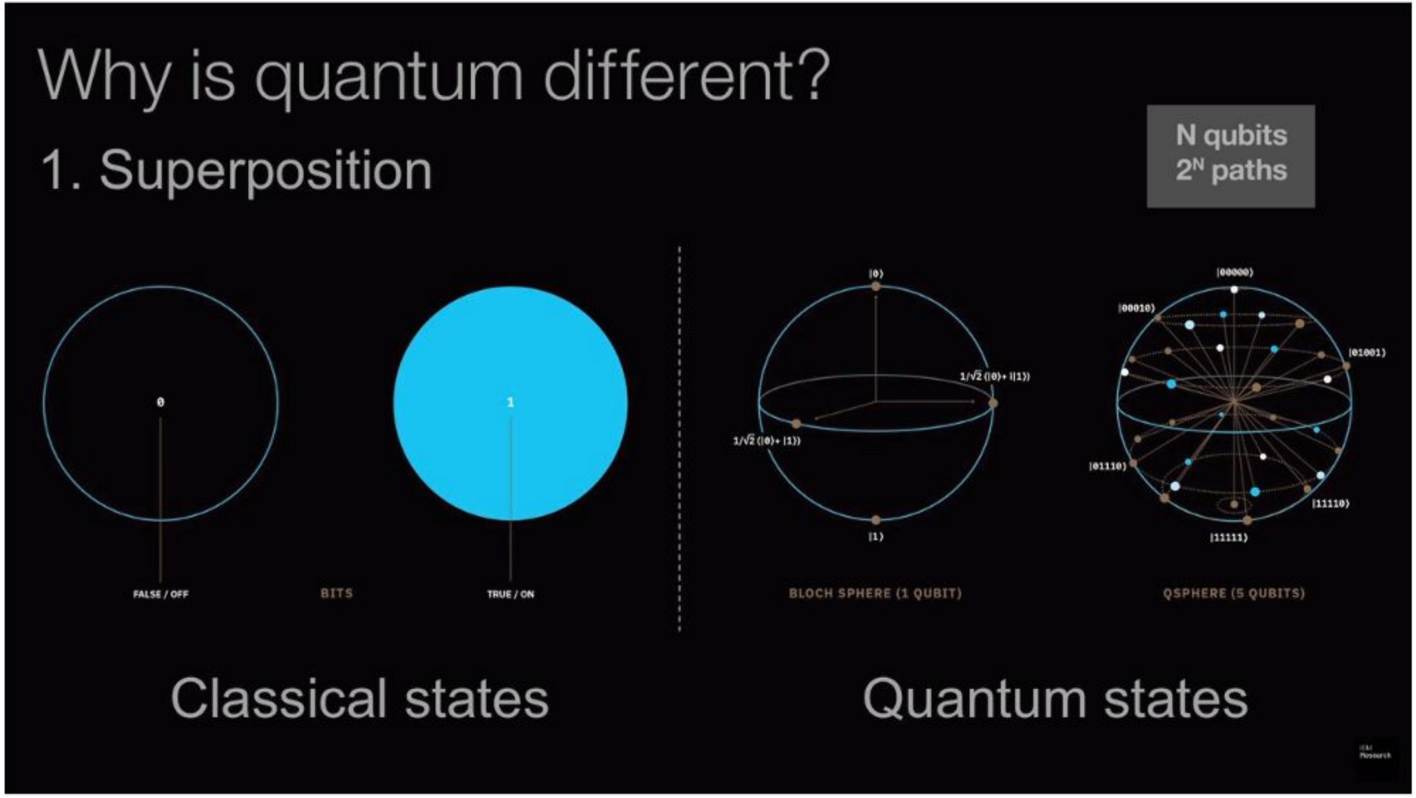
Bra

Ket

$$\langle a | = [a_1, a_2, a_3, a_4] \qquad | a \rangle = \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \end{bmatrix}$$



8:45


Why is quantum different?
1. Superposition
N qubits
2^N paths
0
1
FALSE / OFF
BITS
TRUE / ON
|0⟩
1/√2 (|0⟩+ i|1⟩)
1/√2 (|0⟩+ |1⟩)
|1⟩
BLOCH SPHERE (1 QUBIT)
|00000⟩
|00010⟩
|01001⟩
|01110⟩
|11110⟩
|11111⟩
QSPHERE (5 QUBITS)
Classical states
Quantum states

$$|0\rangle \otimes |1\rangle = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \otimes \begin{pmatrix} 0 \\ 1 \end{pmatrix} = \begin{pmatrix} 1 \cdot \begin{pmatrix} 0 \\ 1 \end{pmatrix} \\ 0 \cdot \begin{pmatrix} 0 \\ 1 \end{pmatrix} \end{pmatrix} = \begin{pmatrix} 1 \cdot 0 \\ 1 \cdot 1 \\ 0 \cdot 0 \\ 0 \cdot 1 \end{pmatrix} = \begin{pmatrix} 0 \\ 1 \\ 0 \\ 0 \end{pmatrix}$$

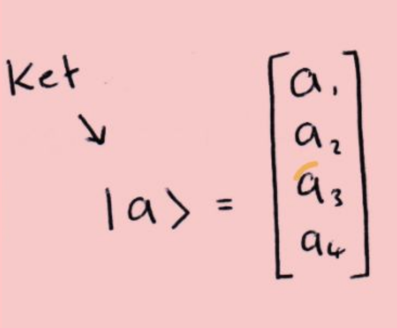
$$\begin{pmatrix} 0 \\ 1 \end{pmatrix} \otimes \begin{pmatrix} 0 \\ 1 \end{pmatrix} \otimes \begin{pmatrix} 1 \\ 0 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 0 \end{pmatrix}$$

$$H \otimes I = \frac{1}{\sqrt{2}} \begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix} \otimes \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} = \frac{1}{\sqrt{2}} \begin{pmatrix} 1 \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} & 1 \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \\ 1 \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} & -1 \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \end{pmatrix} = \frac{1}{\sqrt{2}} \begin{pmatrix} 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 \\ 1 & 0 & -1 & 0 \\ 0 & 1 & 0 & -1 \end{pmatrix}$$

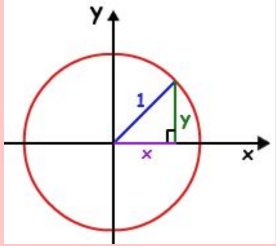
Takeaways

Tensors - Combining bits together using

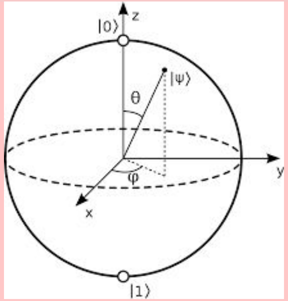
Kets - Dirac Notation for a vector



For vectors/kets - a^2 + b^2 + c^2 + d^2 = 1



There can be complex numbers



Supplementary Videos

Quantum Computing for Computer Scientists - https://www.youtube.com/watch?v=F_Riqjdh2oM&t=3039s

Shor's Algorithm - https://www.youtube.com/watch?v=lvTqbM5Dq4Q&t=734s