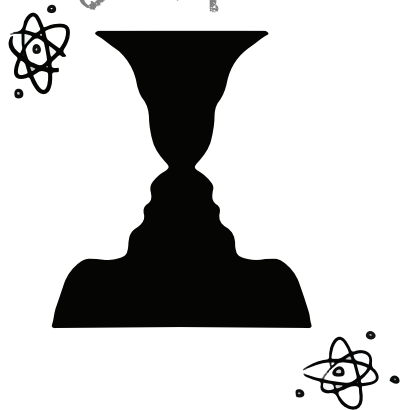


# Quantum Superposition

Quantum Superposition



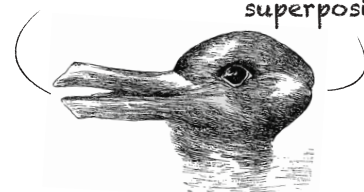
Some pictures hold two images at once!



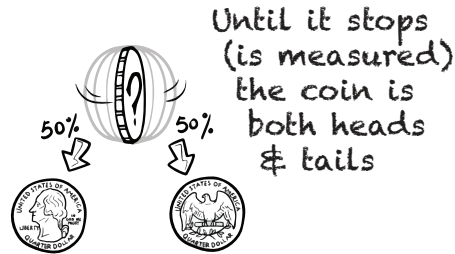
Old or young woman?

I'm a duck and a rabbit...

...in superposition!

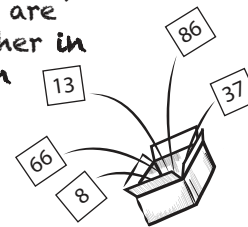


Some things hold two values at once!

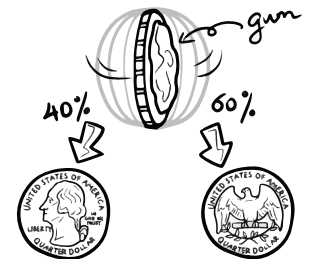


Until it stops (is measured) the coin is both heads & tails

In quantum computing, many values are stored together in superposition

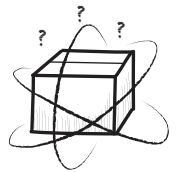


Sometimes, you can adjust the probability of a result

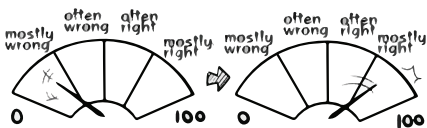


Quantum operations can:

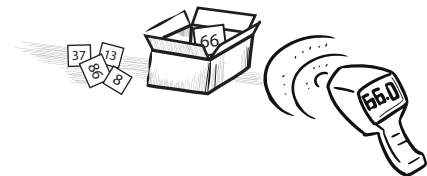
- operate on all values at once
- change the probabilities of each result



Operations gradually refine values until the correct outcome is likely



After measurement, any superposition collapses, leaving only measured values



## Hadamard Gate

The Coin Flip of Quantum!

When the input is 0, it outputs 0 or 1 with a 50/50 chance.

When the input is 1, it also outputs 0 or 1 with a 50/50 chance.



## Hadamard Gate in Quantum Notation

$$|0\rangle \text{ --- } \boxed{H} \text{ --- } \frac{|0\rangle + |1\rangle}{\sqrt{2}}$$

$$|1\rangle \text{ --- } \boxed{H} \text{ --- } \frac{|0\rangle - |1\rangle}{\sqrt{2}}$$

Or, more generally...

$$\alpha|0\rangle + \beta|1\rangle \text{ --- } \boxed{H} \text{ --- } \frac{\alpha + \beta}{\sqrt{2}}|0\rangle + \frac{\alpha - \beta}{\sqrt{2}}|1\rangle$$

But what exactly is H?

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

Find more Quantum Computing zines here: .

<https://www.epiqc.cs.uchicago.edu/resources/>

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