Quantum Computer

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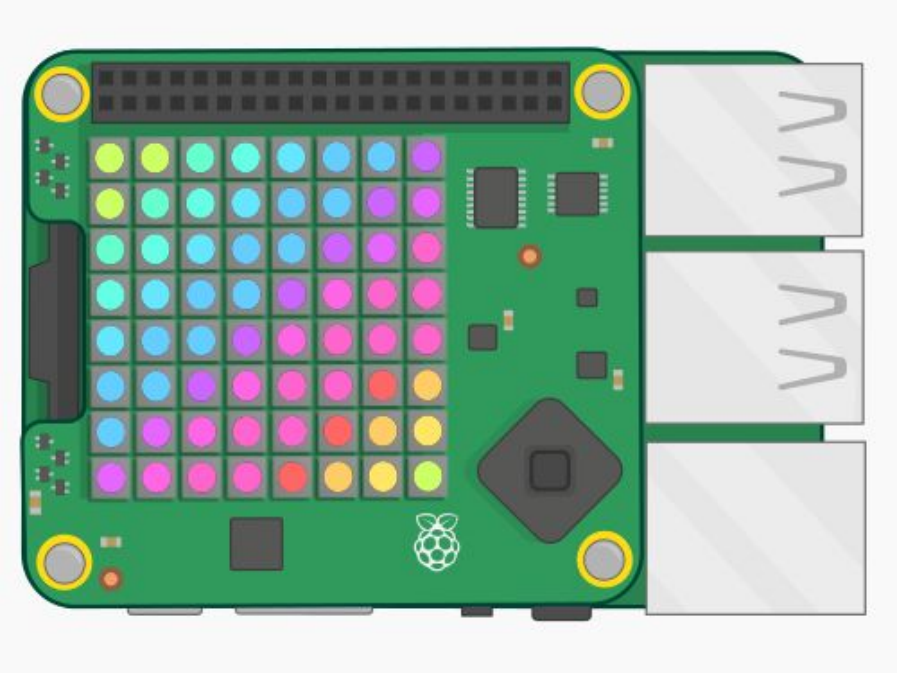
Sense HAT add on and Qiskit



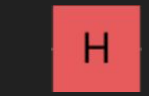
- **SenseHAT**
  - 8 x 8 LED matrix
  - Joystick
- **Qiskit**
  - Open-source software development kit for working with quantum computers at the level of circuits, pulses, and algorithms.

Quantum Concepts

- **Superposition:** when a qubit can be in multiple states at the same time.
- **Entanglement:** essentially, lack of independence.

Circuit Gates

Reset operation: returns qubit to state 0



Hadamard Gate: creates equal superposition

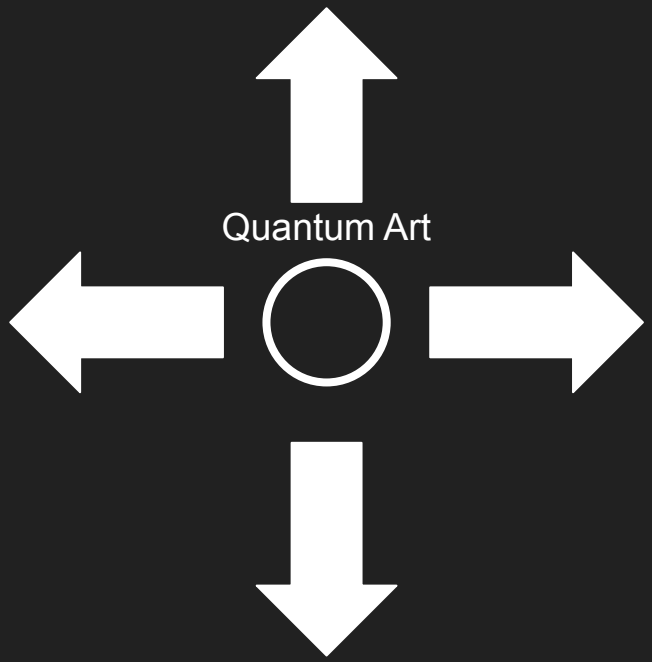
Controlled-NOT Gate: If control qubit is in superposition, it creates an entanglement

Identity Gate: absence of a gate

NOT gate: flips qubit

Joystick

2 qubit Bell State
(entanglement)

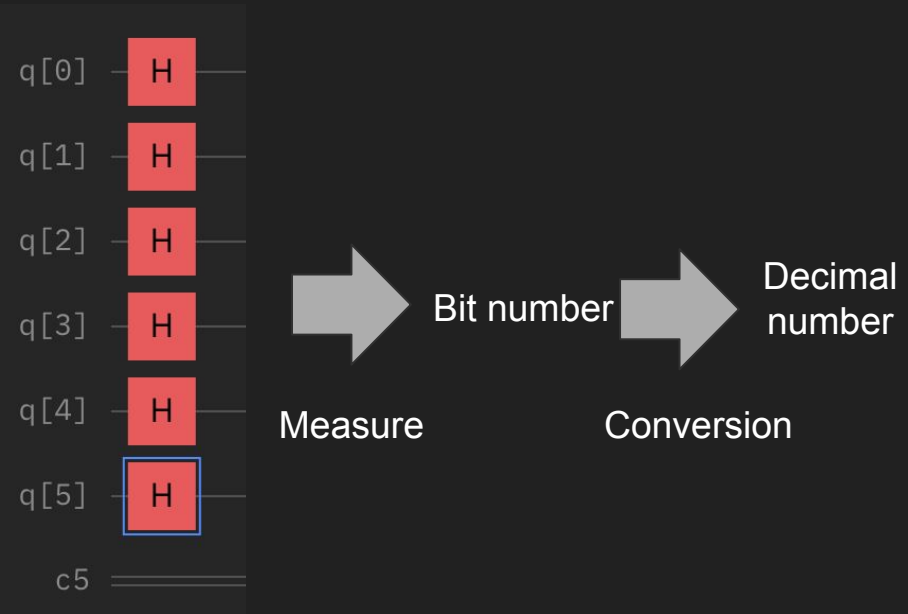


Quantum Coin Tosser
Game
(superposition)

True Random Number
Generator
(superposition)

3 qubit GHZ state
(entanglement)

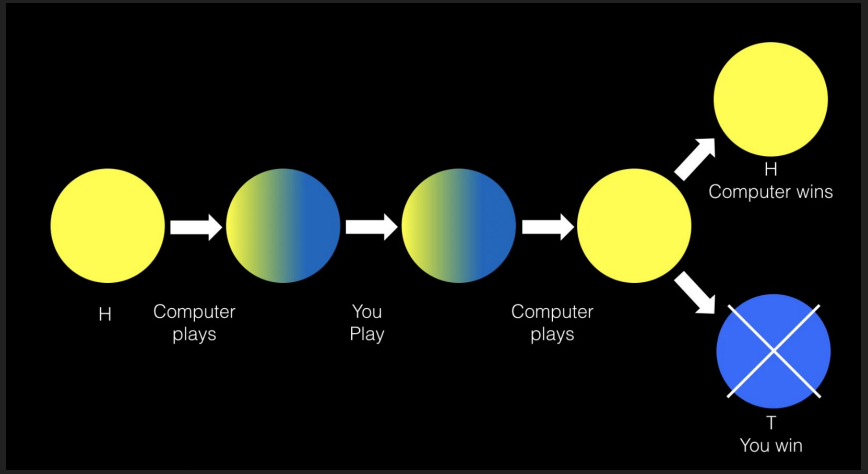
Random Number Generator

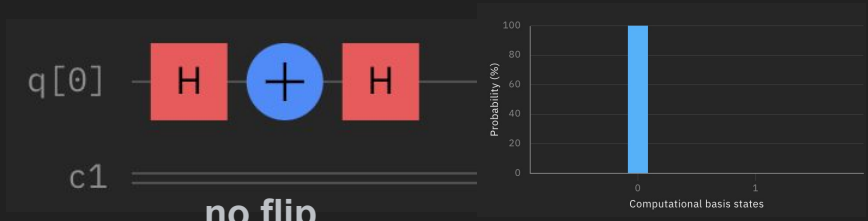


1. Circuit with 6 qubits in superposition
2. When a qubit is measured can randomly be 0 or 1
3. It generates random binary number
4. After converting to decimal number it displays a truly random decimal number

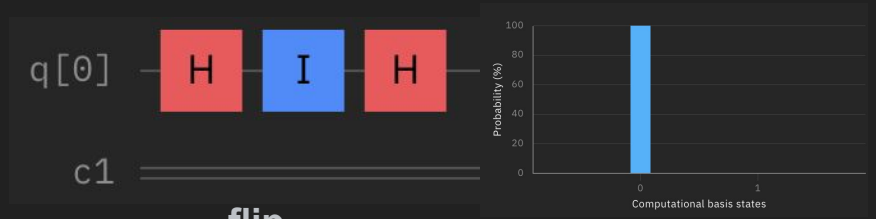
Quantum Coin Tosser

1. Coin shows **heads** and the **computer** will play first.
2. It can choose to flip the coin or not, but you don't get to see the outcome.
3. Next, it's **your turn.** You can also choose to flip the coin or not, and your move will not be revealed to the computer.
4. Finally, the **computer** plays again, and can flip the coin or not
5. The coin is revealed and if it is heads, the computer wins, if it's tails, you win.





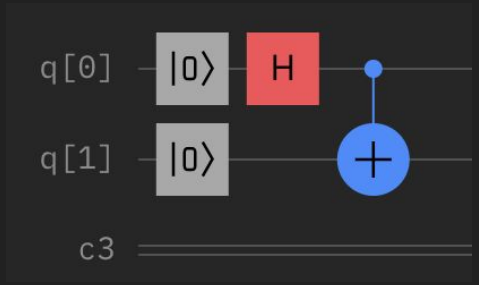
no flip

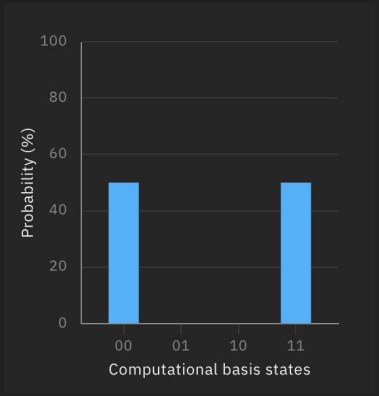


flip

Bell State

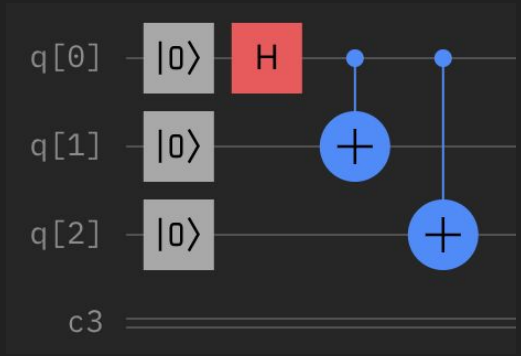
- Maximally entangled quantum state of two qubits
- Qubits are spatially separated
- “Spooky Action at a Distance”
- Q[0] has 0.5 probability to be a 0 or 1 when measured
- If Q[1] is measured after it always has to be the same value as Q[0]

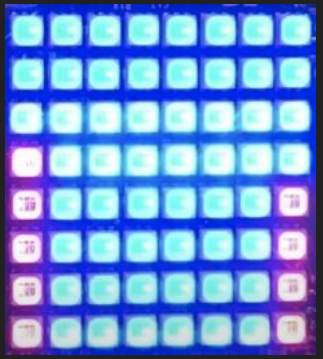


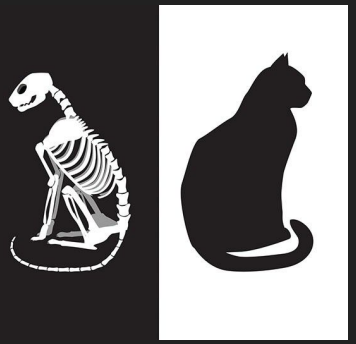


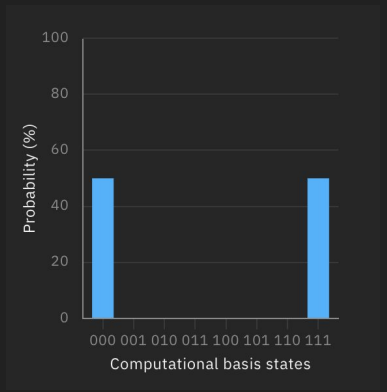
GHZ State (Schrödinger Cat States)

- Entangled quantum state for 3 qubits
- **Cat States:** Two opposed conditions at the same cat, such as the possibilities that the cat is alive and dead at the same time.

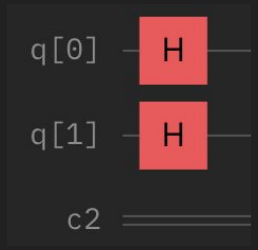




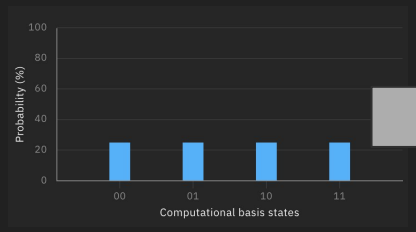




Quantum Art



2 qb superposition



Can generate 4 random numbers when measured

Randomly generated quantum circuit(1) with bell state

Randomly generated quantum circuit(2) with GHZ state