"The 0's, 1's, and Superposition of Quantum and Classical Computers"

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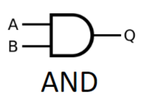
Overview + Findings

- In our project, we explored logic gates in quantum and classical computers.
- Quantum computers, like classical computers, use bits of 0 and 1, but can also exist in a superposition of 0 and 1, or multiple states at once.
- We found that quantum gates can use superposition and perform logic gates that are out of the reach of classical computing.
- Quantum logic gates are not strictly binary and thus, are represented and calculated differently. We demonstrated classical logic gates with an Arduino board and visualized quantum logic gates with the Bloch Sphere.
- Our findings compare the key similarities and difference of classical and quantum computing logic gates.

Logic Gates

How logic gates function within our Arduino:

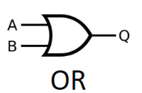
1. AND Gate: If BOTH lights were on, the red light turned on.



AND

A/B	0	1
0	0	0
1	0	1

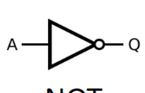
2. OR Gate: If ONE light was one, the red light turned on.



OR

A/B	0	1
0	0	1
1	1	1

3. NOT Gate: REVERSES input



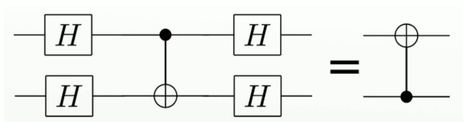
NOT

A/B	Out
0	1
1	0

How logic gates function within quantum mechanics:

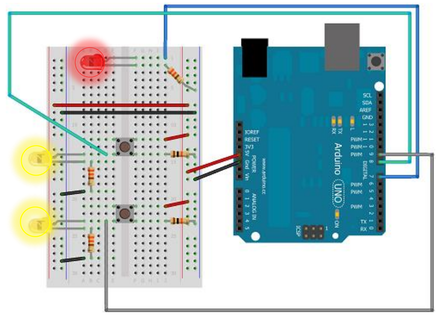
1. Single Qubit Gates/Hadamard:
   - Can flip a qubit from 0 to 1 as well as allowing superposition states

2. Two-Qubit/ CNOT Gate:
   - Allow Qubits to interact with each other and can be used to create quantum entanglement

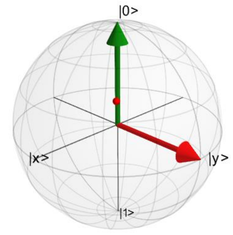


Includes Control Qubit and Target Qubit

Visuals of Quantum Superstition & Classical Logic Gates



Arduino representing AND Logic Gate (Classical)

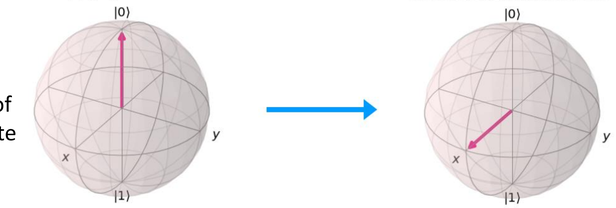


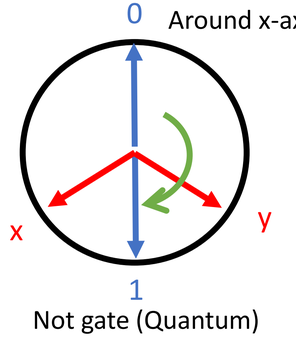
Bloch Sphere in Superposition

NOT

Input	Output
0	1
1	0

Before and After of the Hadamard Gate





Not gate (Quantum)

Real-world application

- Classical logic gates are used in everyday coding to define inputs and outputs
- High-level computations can be done using quantum logic gates within quantum circuits
- Interesting applications currently seen include using quantum logic gates to map optics

References

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