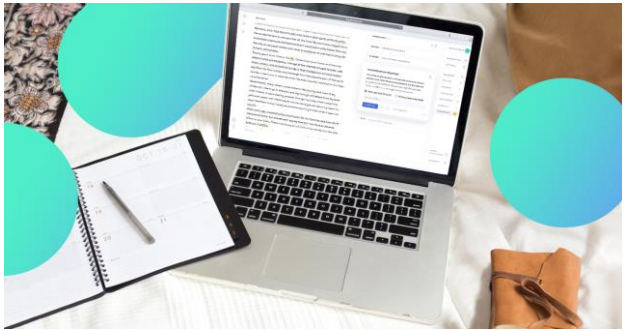
CCNYseniors - Rubiks Cube

By Michael Salamon, Shahid Emdad, Jiseon Yu

Rubik’s Cube

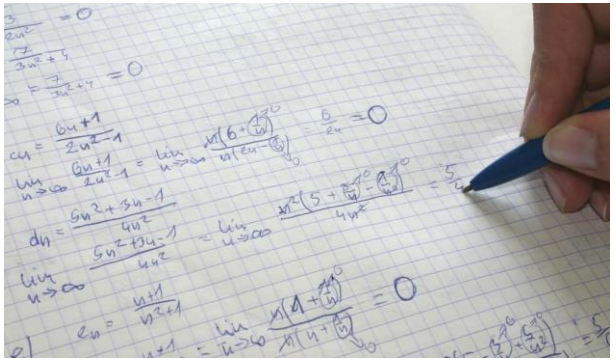
- 350 million Rubik’s Cubes have been sold worldwide
- Inspired the creation of 44 other puzzles w/ higher dimensions or unique shapes (hexagonal, pyramid exc.)
- ‘The Speed Cubers’ Netflix documentary (2020) showed the popularity of Rubik’s Cubes competitions today even though the Rubik’s Cube was invented in 1974.

Rubik's Cubes Faults



- Large learning curve! Need to memorize many algorithms to solve the cube.
- Nearly impossible to solve just by brute force. Must follow tutorials online.
- Toys R Us closed its last location! Where are people to buy their physical cubes? (Source: LinkedIn)

Way to improve the game?



- It took years of math to find out that any scrambled 3 by 3 by 3 Rubik's Cube could be solved in 20 moves or less. So many combinations… (source: It's not you – solving a Rubik's cube quickly is officially hard | New Scientist)
- There should be a feature in the game that rewards users for putting more effort since getting a solved cube is so difficult.
- The element of chance in games makes viewership more interesting! Some level of unpredictability keeps people on the edge of their seats. (source: Chance and Skill in Game Design « The Acagamic)

Quantum Superposition

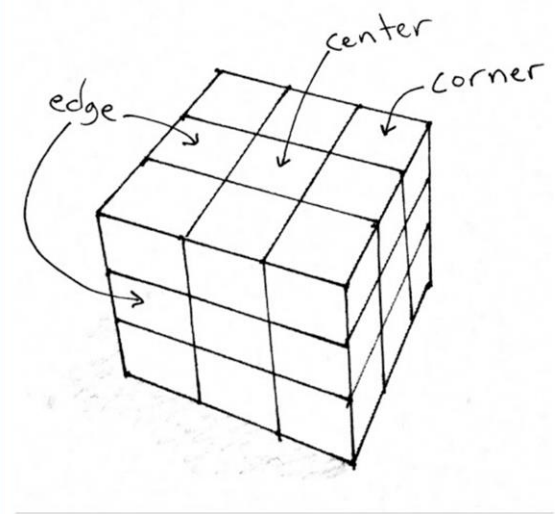
Superposition is a special Quantum Property. It is the process of the coin being flipped neither heads nor tails.

- Quantum:
  - Physical system has a hilbert space associated with it
  - Schrodinger equation

$$\hat{H}\Psi = E\Psi$$

  - Measuring in a probabilistic collapse in vector space schrodinger's cat.
  - macroscopic object because it is doing the measuring
  - quantum effects take place in small space and cold temperatures.
  - The Qubits are defined in terms of a orthonormal computational basis.
  - single qubit as a block sphere

Mechanics of pieces exchange



There are two valid choices for a quantum switch:

1. corner + corner
2. edge + edge

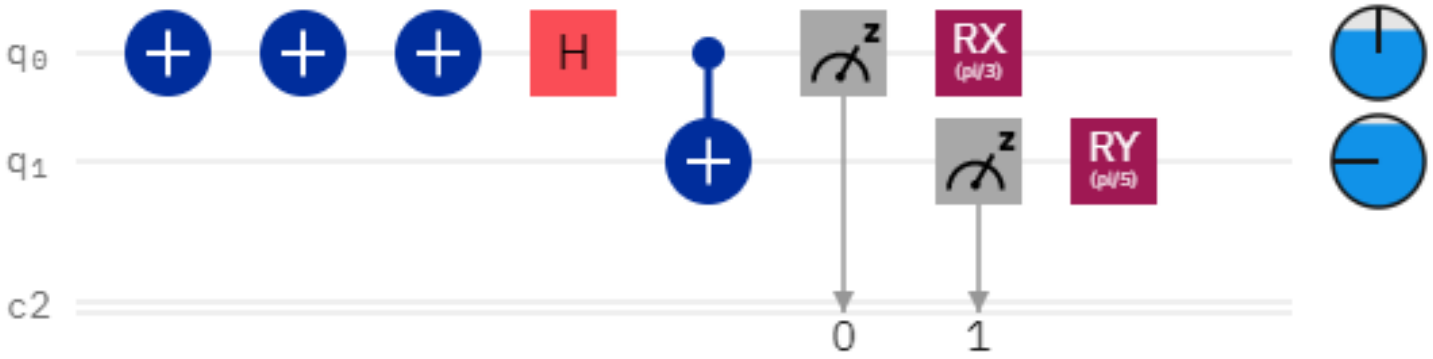
There are 4 invalid choices for a quantum switch:

1. corner + edge
2. center + corner
3. center + edge
4. center + center

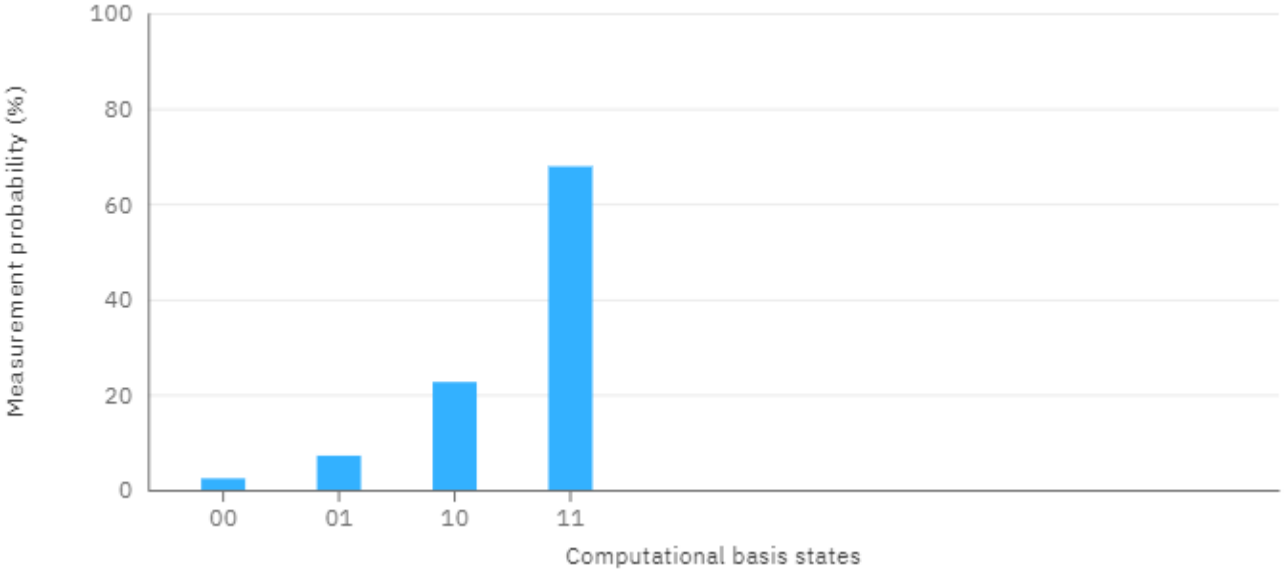
However, this can be narrowed down to:

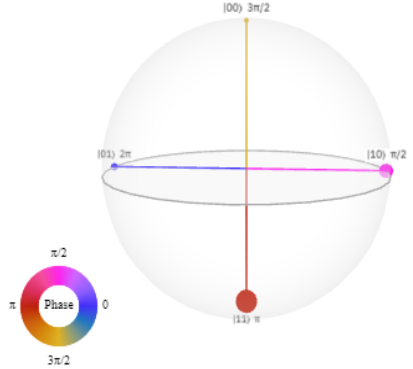
1. corner + edge
2. Any choice involving a center piece

Circuit

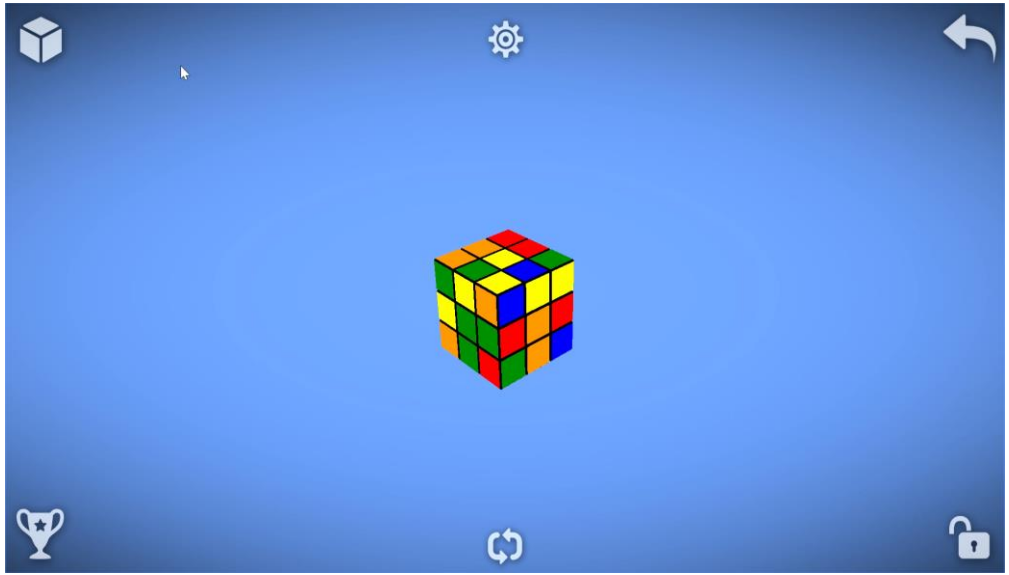


Measurement prob. + Qubit positions





Video 1



- Here is an example where this feature makes things easier. Although this side is filled w/ all white, the corner pieces are mismatched! If the user had the option to do quantum superposition twice exchanging the 4 pieces, this level would be perfectly solved!

Open Source Rubik's Code

- The video was purchased from the Microsoft App Store courtesy of: Magic Cube Puzzle 3D from Maximko Online.
- The code we implemented was open source pygame code of Rubik's Cube courtesy of _____

Qiskit backend

The backend was done with Quantum Computing IBM website and jupyter notebook. First we imported the necessary elements and then we created two circuits and then we gave me CNOT GATE and other MOVE GATES. The probability is shown in graph

Improvements?

Check out our GitHub repository!