

Quantum Operation Games

Explore how quantum operations work

Learning Goals

- Understand how to use quantum operations for simple circuits.
- Understand that quantum computers are very unreliable.
- Understand how to simplify quantum circuits.

Quantum Computing Tie-In

Current quantum computers are small and unreliable. Quantum operations are structured very differently from classical operations.

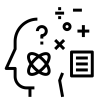


Materials

- Qupcake game
- Crazy Circuits game

Preparation

- None



Background Knowledge

Operations: Classical computers are built to mimic how humans perform arithmetic calculations (and now do so much more). Quantum computers, on the other hand, are designed based on quantum properties (superposition and entanglement, the subject of different activities) and are only more powerful than classical computers when performing tasks classical computers do not do well. These phenomenon change computation at the most basic level - much simpler operations than addition and subtraction. In order to understand how superposition and entanglement provide gains, we must first understand the basic operations in quantum computing: not, swap, cnot.

Fragility: Classical computers store simple values in memory, and the storage devices are able to both measure and retain the value when you read out of memory. These devices rarely experience errors, unless they are on satellites in space without the atmosphere to filter out much of the sun's powerful radiation. Quantum computers, however, have a very complex, fragile state at the molecular level. Qubit are very susceptible to errors due to minor perturbations such as vibrations, light, sound, or temperature changes. Programs must be as short as possible so they can complete without errors.

Engage

1. Explain that today the class is going to do some activities that introduce students to the basic operations used in quantum computing. What is quantum computing? You have some short videos to introduce the topic.
2. Play the first QIS intro video - less than 3 minutes
3. Play the second video that introduces quantum computing, specifically - **up to 4 minutes**

Activity

4. Playing Qupcake
 - a. Explain that they are going to play a game featuring an absent-minded baker. You are the server, and the baker keeps making the wrong thing! Your job is to use special quantum operators to transform the cupcakes into the ones the customers ordered.
 - b. Play the introduction to Qupcakes video
5. Set a timer for 30 minutes
6. Send students to: (URL released April 11) and click “Go” button under Qupcakery picture.
7. Discuss with the students what they thought of the game.
 - a. Did the operations make sense?
 - b. What did they think of the H gate and the superposition cupcakes? Was that interesting?
 - c. Was there anything challenging about the game? Would they have played more had they had the chance? Would they like to see more levels?
8. Play the final video that ties the game mechanics to quantum systems.

Additional QuanTime, April 2022 FAQ

1. When does QuanTime take place?

URL will be active April 11th through May 31st

2. How long does the activity take?

The activity takes approximately 45-60 minutes.

3. What discussions should teachers have with students?

The discussion prompts are in the facilitation guide

For additional questions about the activities, contact Diana Franklin and dmfranklin@uchicago.edu