Quantum Computing for K-12 using Blockly

Team members: Joshua Pomeroy, Robert Duncan , Santiago Agudelo, Steven Acosta | **Mentor:** Thang N. Dinh

Motivation

Last year's VCU Capstone project introduced K-12 students to programming through a Tic-Tac-Toe game using Quantum Computing and Blockly. This year, our project builds on that by adding games like Mancala and Connect4, along with features that enhance learning:

- **Enhanced Learning Experience**: Engaging students with quantum and classical CPU opponents.
- **Multi-Level Curriculum**: Adjustable difficulty levels for progressive learning.
- **Auto grading Feedback**: Real-time evaluation through CPU components.

These improvements demonstrate the potential of quantum programming for both current and future applications.

Challenges

- **Feature Development:** Designing and implementing new features requires ongoing creativity and technical expertise. New features need to be thoughtfully integrated into the original program to ensure compatibility and relevance.
- **Engagement-Focused Gameplay:** Developing games that are both educational and entertaining to maintain student engagement.
- **Programming Proficiency:** Simplifying quantum mechanics concepts for students with limited programming experience without losing educational depth.
- **Interdisciplinary knowledge:** Developing educational games that engage students requires an interdisciplinary approach, incorporating physics, math, and computer science.

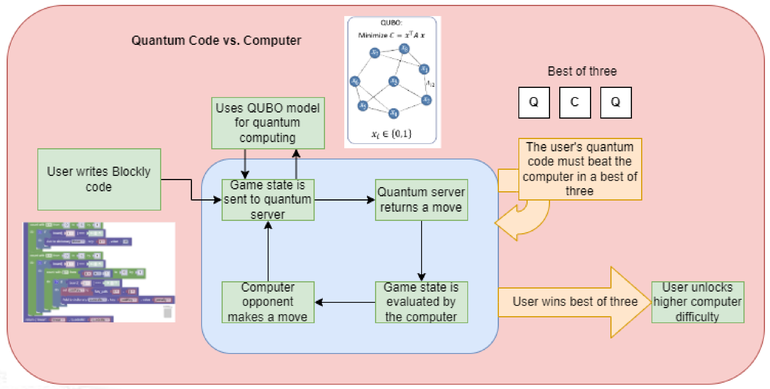
Solutions

- **Structured Development Process:** Using a development pipeline based on brainstorming, team feedback, and iterative testing to efficiently implement new features..
- **Enhanced Aesthetics:** Revamping the game's visual design—improving fonts, colors, and interface elements—to make the games more inviting and enjoyable for students.
- **Local Storage for Seamless Play:** Introducing a save-and-resume system that allows students to pick up where they left off, facilitating smoother transitions between games and sessions.

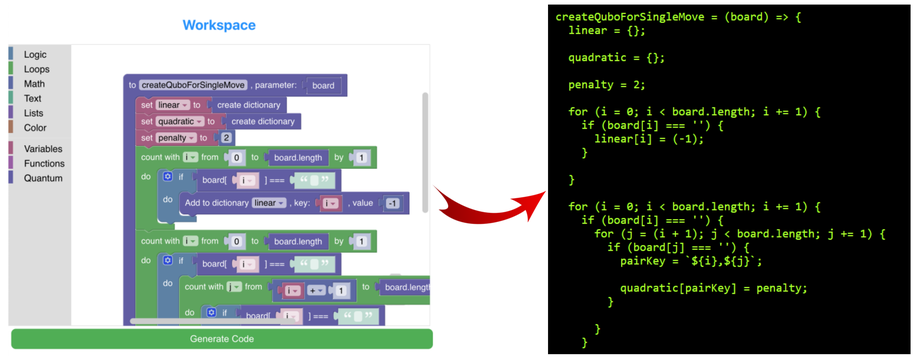
Learning-Centric Design

- **Game Saving and Switching:** Students can save their progress, switch between games, and resume later, ensuring a smooth learning experience across multiple activities.
- **CPU Opponents for Auto grading:** Players can challenge classical or quantum CPU opponents with adjustable difficulty levels or even observe CPU vs. CPU matches. These interactions help students understand computational strategies while providing automatic feedback to reinforce learning.

Architecture Design



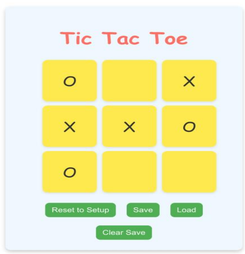
Block based quantum code



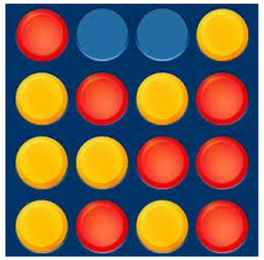
User made block-based JS code writes a QUBO function to be sent to a quantum server to process a move

Current and Upcoming Games

Tic-Tac-Toe



Connect4



Mancala

Tools and Libraries

Blockly JS React B Flask

D:wave Ocean