Quantum Computing for K-12 with Blockly

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Last year, a VCU Capstone team worked on a project about Quantum Computing with Blockly to design a Tic-Tac-Toe game that would showcase the basics of computer programming to Students K-12 and help them gain a better understanding of the field to the point where they may want to pursue it. This year, our team's goal is to build upon that by refining the initial game, adding new games to play and adding multiple features like quantum cpu vs normal cpu opponents and difficulties. This is to showcase more complex Blockly coding to the students studying this game so they can see the different applications and uses quantum programming can have and to show how much you can do with it now and in the future.

During the spring semester, we have added a new game, Mancala, and incorporated it into the website with the other games. We have also restructured the way that Blockly blocks are defined in our codebase to allow easier creation of new blocks. We accomplished this by separating the ways blocks are defined into three files, the toolbox configuration, block imports, and a folder for individual block information. In the Blockly programming interface, we have added new blocks that make use of PyQUBO, a Python library designed to solve QUBO problems. The new PyQUBO blocks are sent to a custom server, where the problem is reduced using weights and constraints to produce a single move for the selected game. The new PyQUBO blocks include the declaration of binary, integer, binary array, and two-dimensional array variables, and the declaration of constraints that allow the maximization problem to be solved by the server.

Keywords:
- **QUBO**
- **Blockly**
- **PyQUBO**
- **Tic-Tac-Toe**
- **Connect 4**
- **Mancala**
- **Weights**
- **Constraints**