Team Quantum AI:

Quantum Mancala Capstone

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Sponsor: IBM-HBCU Quantum Coalition

IBM Q

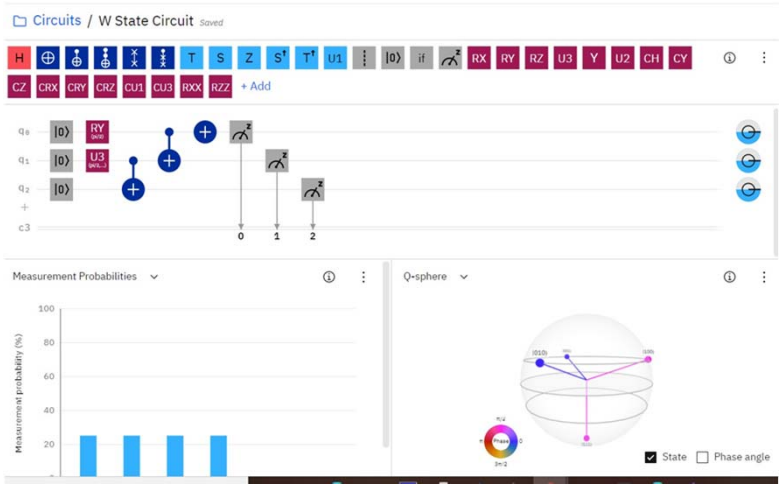
HBCU QUANTUM COALITION

Qiskit
Elements for building a quantum future

Problem Definition

Problem Statement: Project goals and approach initialized through learning basic quantum computing information, composing quantum circuits, and researching quantum based game articles centered on quantum game development, further clarifying the long term goal of the project, **designing a Quantum Game to be used within the IBMQ Experience framework as a testbed for future Machine Learning/AI algorithms**; resolving the issue of previously unknown information on this topic and illuminating the paths to accomplishing both the course and long term goals.

Design Requirements



NIST free

IBM Q

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Elements for building a quantum future

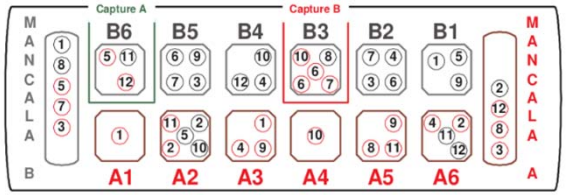


Figure B

- Introduces superposition and entanglement
- Qubits measured

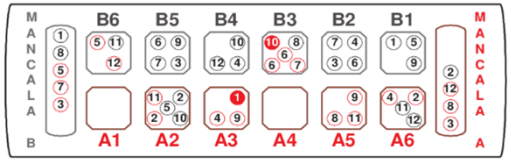


Figure C

- Collapsed state not resulting in capture
- Not collapsed to capture pit

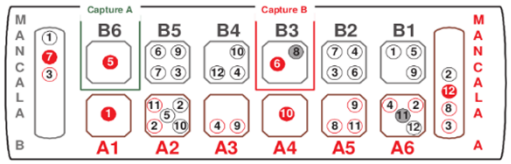
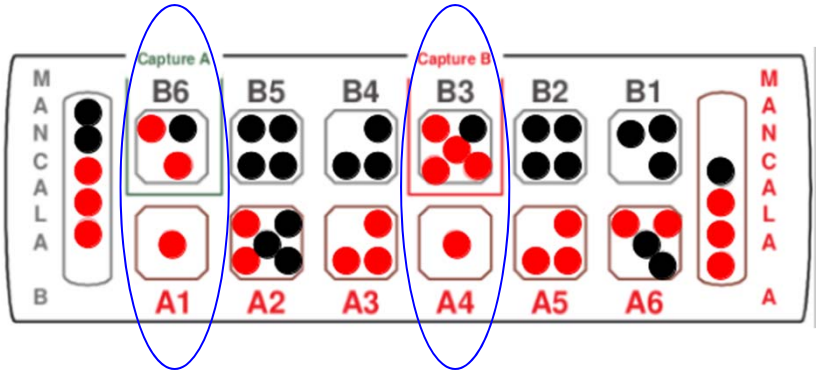


Figure D

- Collapsed state resulting in capture
- Collapsed to capture pit



- No entanglement
- Superposition: Capture A and B
- Measurement will result in Mancala A or B

Solution Design- Capture Position Design

Quantum AI Progress Presentation 1: Quantum Mancala Capstone

Erin Strickland, Robert Coleman, Jordan Aley, Jonathan Williams
February 23, 2021

Sprint 1: Feb 8 - Feb 19

Piece 1: Outline a python code for Classical Mancala/understanding Classical Mancala

Increment 1: Outlining, examining and testing the Classical Mancala code for errors so that quantum concepts can be integrated

Agile Implementation Process- Sprint 1

Quantum AI Progress Presentation 2: Quantum Mancala Capstone

Erin Strickland, Robert Coleman, Jordan Aley, Jonathan Williams
March 16, 2021

Sprint 2: Feb 22 - Mar 5

Piece 2: Research and Define the Quantum Integration

Increment 2+1: Define potential areas and methods to incorporate Quantum mechanical concepts into game and fully understand how Classical Mancala code operates.

Planned Weekly Tasks

Week 1:

- Gain strategic insights from code
- Read/note Q papers re circuit incorporation/Q concepts
- Compare those papers' techniques with our Q goals
- Refine intended Q rules for code

Week 2:

- Define Q insertion points
  - Define what areas in the game and code best benefit from more strategy (via Q concepts)
  - Define how to incorporate quantum concepts into rules of game

Agile Implementation Process- Sprint 2

Quantum AI Progress Presentation 3: Quantum Mancala Capstone

Erin Strickland, Robert Coleman, Jordan Aley, Jonathan Williams
March 30, 2021

Sprint 3: Mar 8-19

Piece 3: Create Quantum Circuits (IBMQ Circuit Composer)

Increment 3+2+1: Create quantum circuits to implement into the classical code by utilizing the IBM circuit composer based on specific strategic areas the research suggests we apply the Quantum mechanical concepts into the game.

Planned Weekly Tasks

Week 1:

- Go IBM website to compose quantum circuits based off our python code
- Review circuits and quantum gate operation
- Demonstrating knowledge of gate/circuit creation with sample circuits, Creating small circuits based on current research

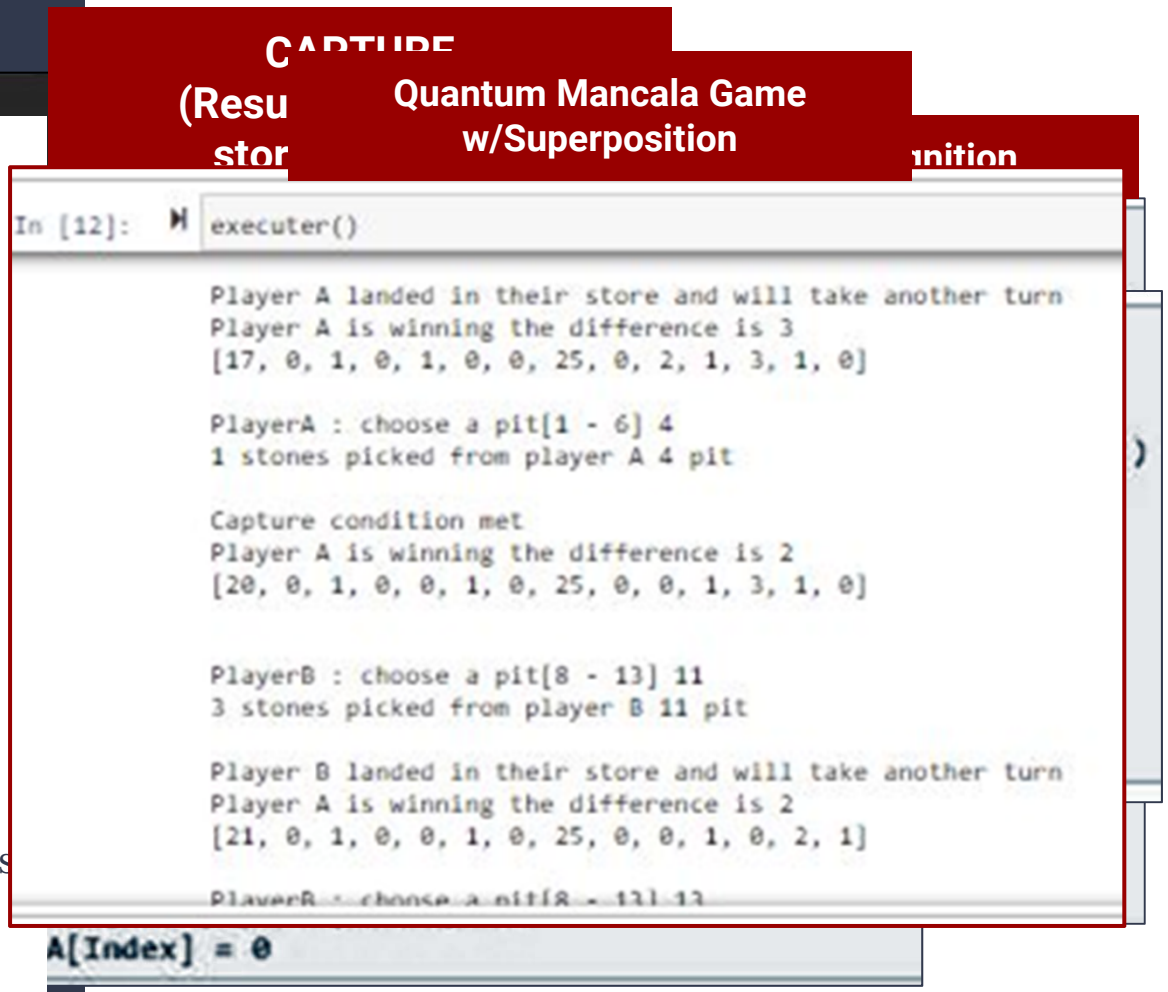
Week 2:

- After we compose the quantum circuits we need to test them to make sure we built the circuits properly
- Compare our research use of quantum circuits with our current code

Agile Implementation Process-Sprint 3

Conclusions

- Created Quantum Game
- Successfully implemented quantum mechanical concept of superposition
  - Confirmed capture recognition
  - Implemented quantum circuit into code
  - Tested the game between team members
- Future implementations include:
  - Refining the capture position parameters; refining the code
  - Adding entanglement
- Eager to continue working on this project over the summer



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Demonstration