Quantum Games:
The Future of Gambling

Quantum Computing will revolutionize the gambling industry as it allows for true randomness.

By Kasra Mazaheri, Andrii Zahorodnii,
Fedir Yudin and Charis Georgiou

Introducing Quantum Blackjack

Or QuackJack™, if you will.

Like Blackjack, but entangled.

How it Works

01

A card in this game is a superposition of 0 and 1 (basically a qubit). In our case, we will only be using the 0, 1, + and - states.

02

The first player has the option to draw 2 cardsat a time (with a maximum of 8) or stop.

03

After they (the first player) stop, they have the option to apply the CNOT gate at most 8 number of times upon any two cards.

04

The second player repeats the same process.

05

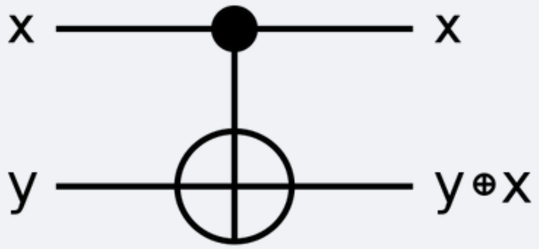
The resulting circuits are then evaluated and the value of the cards are measured.

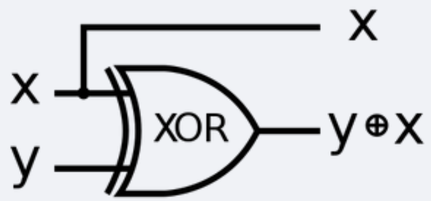
Result

If the sum of the values of the cards of a player is equal to or more than 5, the player loses that round. If both players have a value less than 5, then the player with the higher sum wins.

A refresher on the CNOT gate

The CNOT gate operates on a quantum register consisting of 2 qubits (or cards, in our case).
CNOT is essential in Quantum Computing as it can be used to create entanglement and disentanglement.



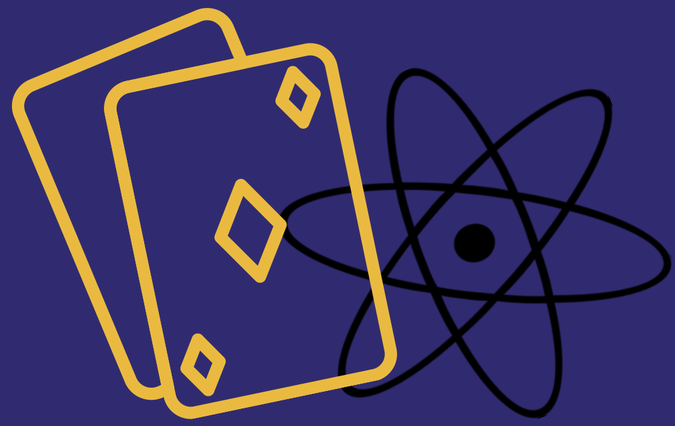


input		output	
x	y	x	y+x
|0⟩	|0⟩	|0⟩	|0⟩
|0⟩	|1⟩	|0⟩	|1⟩
|1⟩	|0⟩	|1⟩	|1⟩
|1⟩	|1⟩	|1⟩	|0⟩

input		output	
x	y	x	y+x
0	0	0	0
0	1	0	1
1	0	1	1
1	1	1	0

Comparing QuackJack™ with the Classic BlackJack

How does "classic" Blackjack relate to this Quantum version?



I.

In Blackjack, cards have predetermined values whereas in Quackjack they are in a superposition and their values will only be determined after the measurement.

II.

Unlike classic Blackjack, players can entangle their cards in Quackjack using the CNOT gate in favor of certain outcomes.

III.

Otherwise, the games follow the same structure.

The Future for QuackJack™: The Quantum Blackjack

There can be many possible developments and improvements to this game alone.

01

Expanding the set of cards. Possibly to all possible superpositions.

02

Adding a variety of quantum gates, allowing for more complex strategies.

03

Allowing for players to apply gates to their opponents cards.

04

Allowing for cross-player entanglements. Making the game way more complicated. And fun.

The QuackJack™ experience

```
PLAYER 1: You drew [1] and [-]
PLAYER 1: Your circuit so far:
q_0: - X -
q_1: -
q_2: - X -
q_3: - H -
q_4: - X -
q_5: - X - H -
PLAYER 1: Draw (Y/N)? Y
```

```
PLAYER 1: Your circuit so far:
q_0: - X -
q_1: ---------- X -
q_2: - X -
q_3: - H -
q_4: - X -
q_5: - X - H -
c: 6/═══════════
PLAYER 1: Apply a Controlled-NOT gate (Y/N)? Y
PLAYER 1: Cards to apply the gate to (ex. 0 1): 2 3
```

```
PLAYER 1: Your circuit is:
q_0: - X - M -
q_1: ---------- X - M -
q_2: - X - M -
q_3: - H - X -
q_4: - X - M -
q_5: - X - H - M -
c: 6/═══════════
          0 4   2 3 1 5
```

```
== [ QUACKJACK ] ==

PLAYER 1: Your circuit is:
q_0: - H - M -
q_1: - H - M -
q_2: - X - M -
q_3: ---------- X - M -
q_4: - X - H - M -
q_5: - X - H - M -
q_6: - H - M -
q_7: ---------- X - M -
c: 8/═══════════
          6   1 2 5 0 7 3 4

PLAYERS: Press ENTER to run your circuits on IonQ!

PLAYER 1: Evaluating your circuit...
.........................
PLAYER 1: Your qubits evaluate to: [1, 0, 1, 0, 0, 1, 1, 1]
PLAYER 1: You receive a score of 5

WINNER: PLAYER 1

Play again (Y/N)?
```

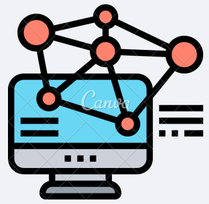
```
PLAYER 1: Evaluating your circuit...
............
PLAYER 1: Your qubits evaluate to: [1, 0, 1, 1, 1, 0]
PLAYER 1: You receive a score of 4
```

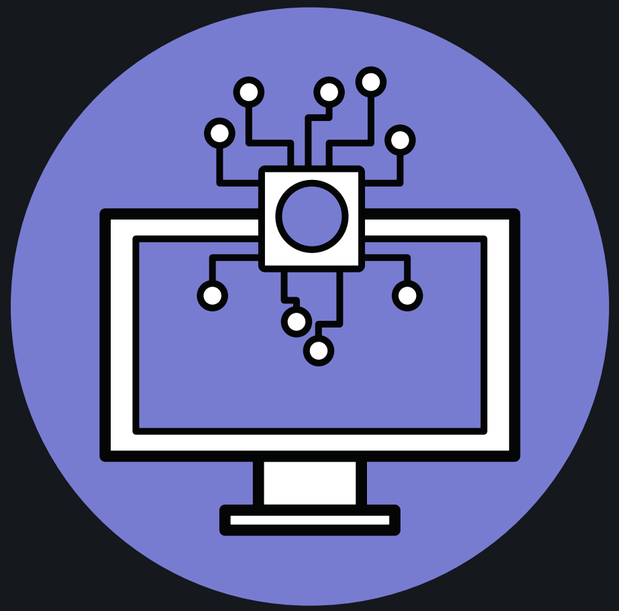
```
PLAYER 2: Evaluating your circuit...
............
PLAYER 2: Your qubits evaluate to: [1, 1]
PLAYER 2: You receive a score of 2
```

```
WINNER: PLAYER 1

Play again (Y/N)?
```

Thank you for your time!!





Link to project's repository:

https://github.com/azaho/2022_microsoft_ionq_challenge