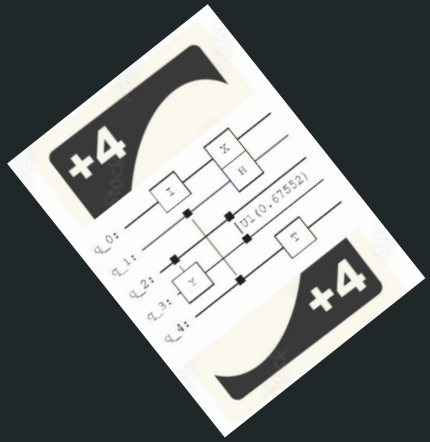
MIT iQuHACK 2022



QUnoJenga
Quantum Uno-Jenga

By **Quantum111**

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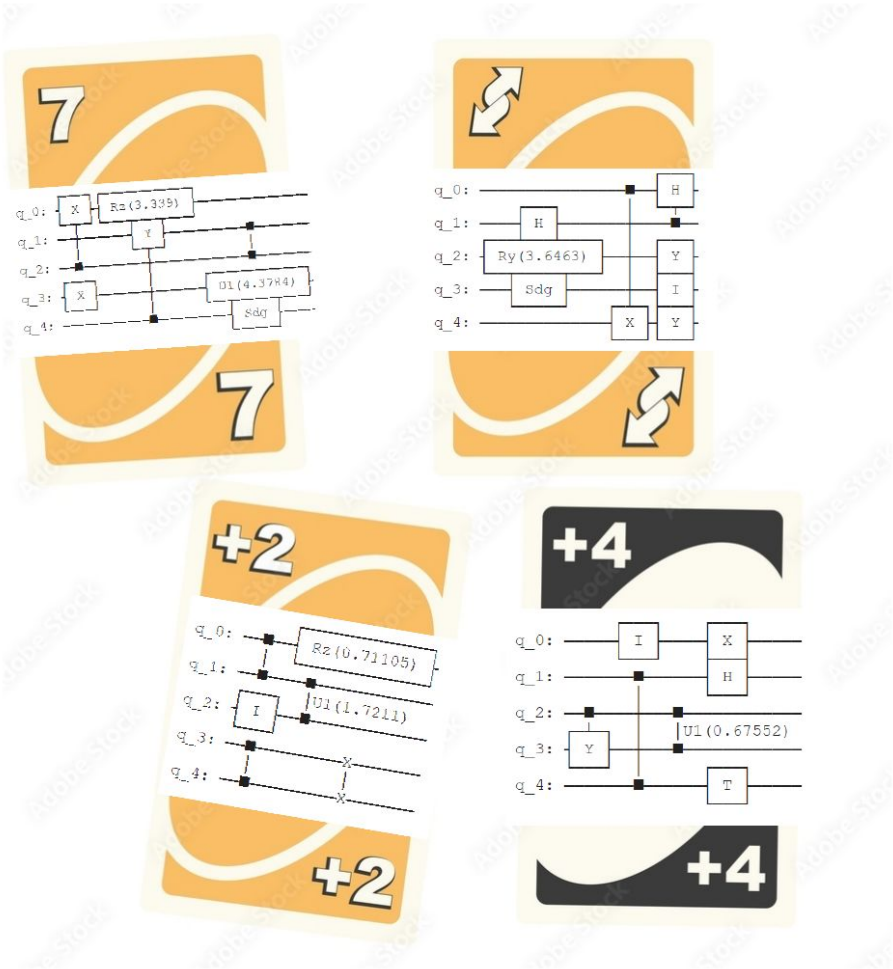
Classical Uno

- Any card you put down must either be the same color or the same number with the top card in the center.

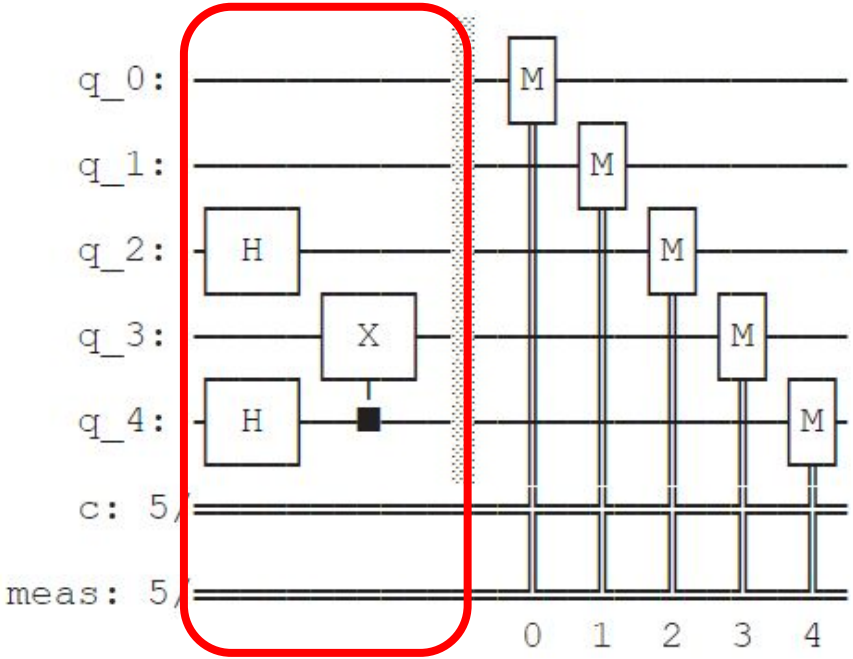
Quantum Uno

- Each card has a different random circuit on it.
- Each new card you put down, adds a new circuit to the previous one.



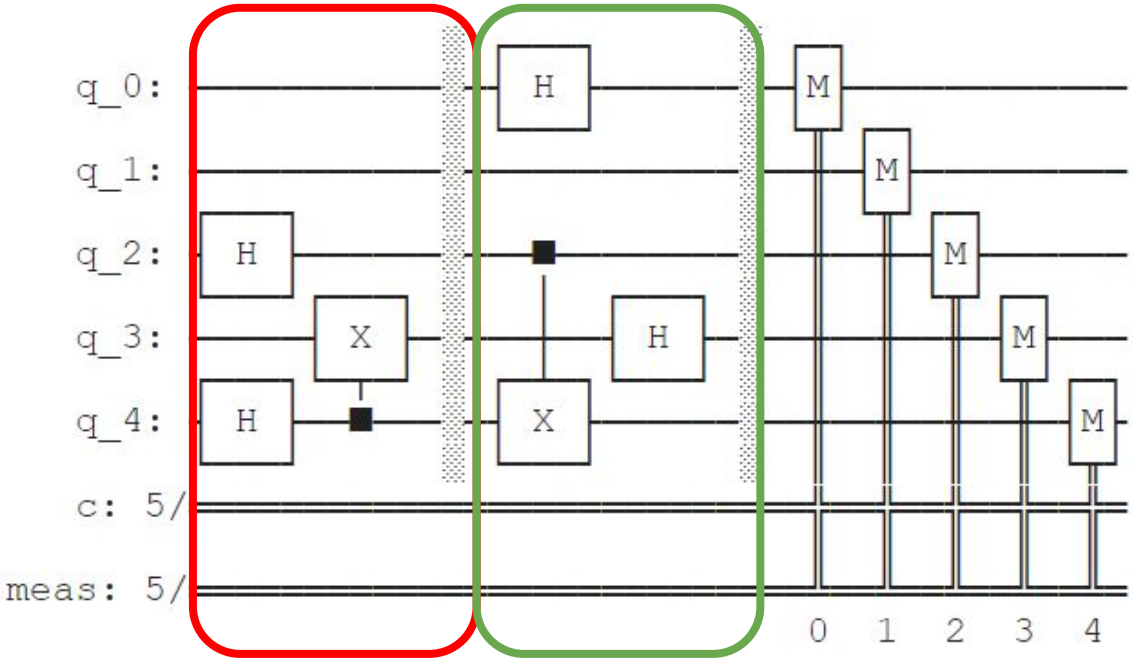
What happens when we add a card?

Jenga Principle of Stacking Cards



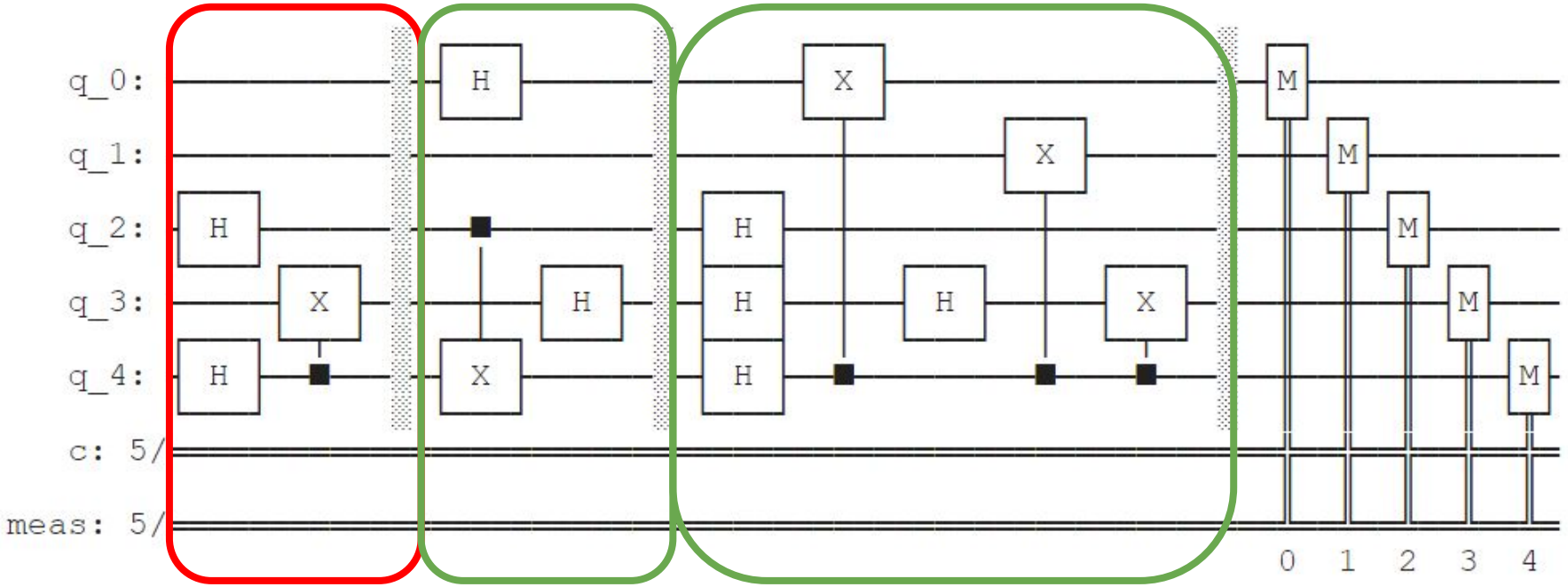
Red-2

Jenga Principle of Stacking Cards



Red-2 **Green-2**

Jenga Principle of Stacking Cards



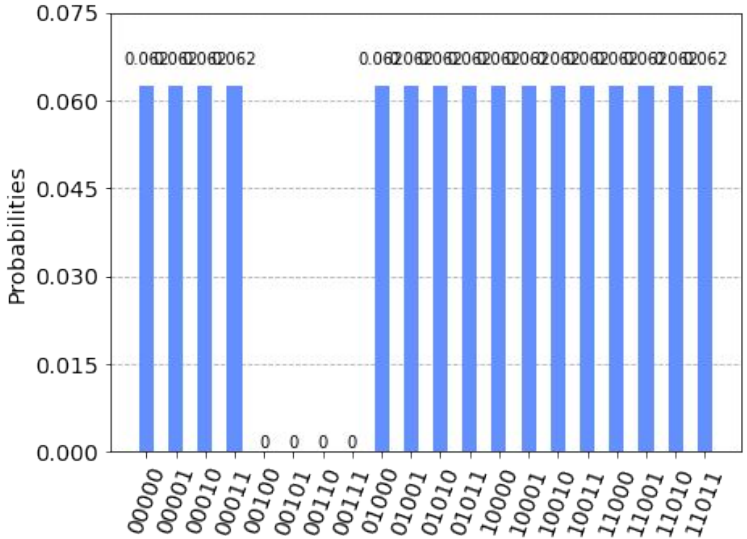
Jenga Principle of Stacking Cards

- As we stack cards on top of each other, the circuit length becomes longer and quantum noise starts to dominate.

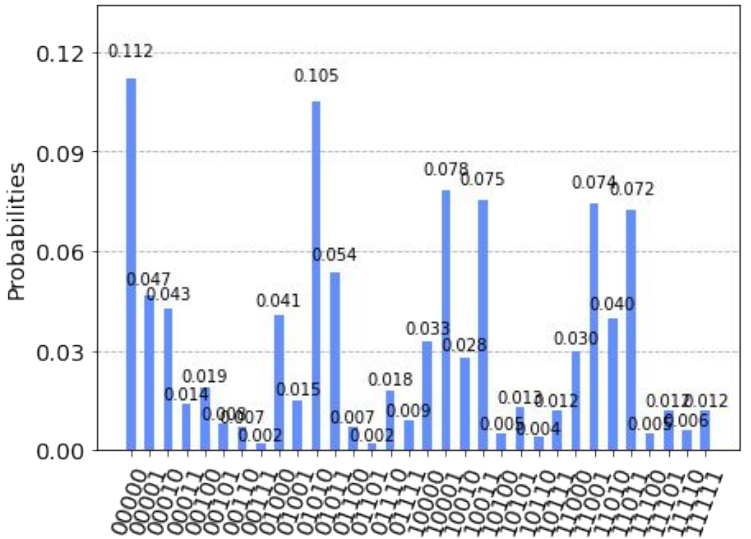
What do we do with the hardware calculation?

Simulation VS Quantum Hardware

- Ideal



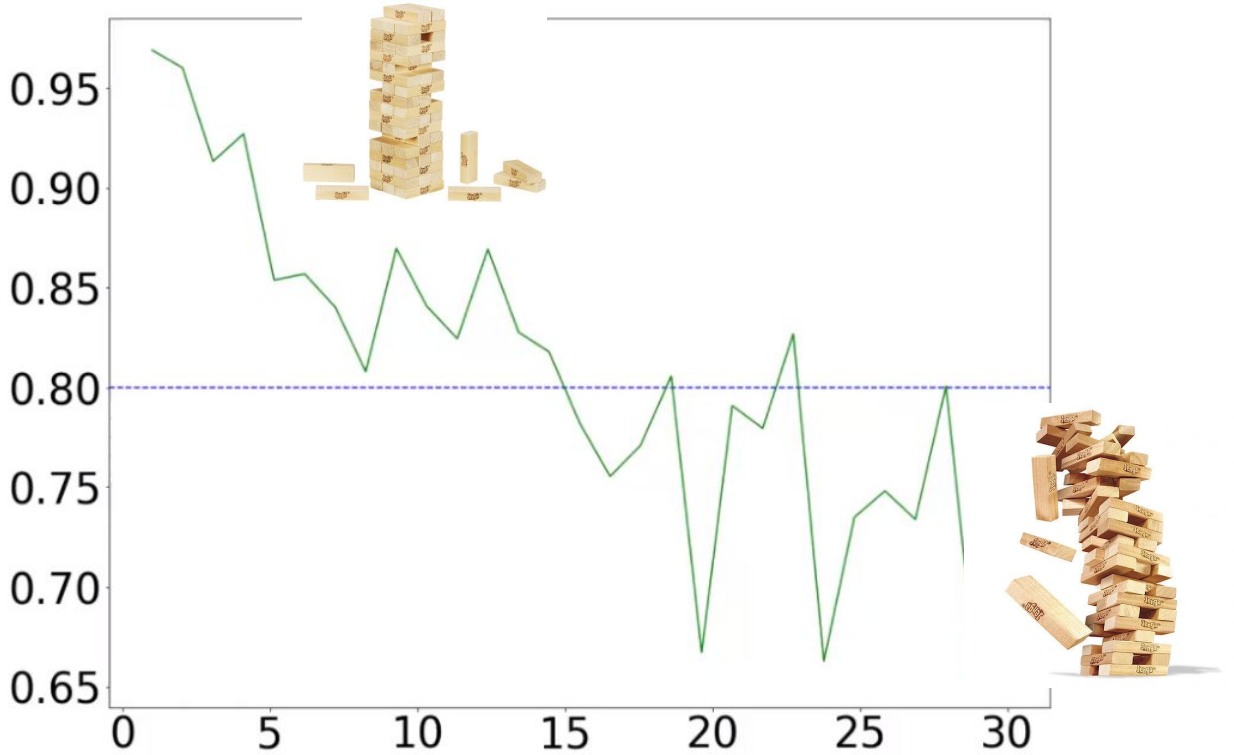
- Noisy
- With increasing depth of circuit, the result has a higher chance of being erroneous.



Overlap between simulations and real hardware

Overlap

$$|\langle \Psi_{simulation} | \Psi_{real} \rangle|^2$$



Card number (approx)

If the overlap between the two probability functions > 0.80: the tower is still standing

If the overlap between the two probability functions < 0.80: the tower crashes

Video

Final move

```
Leyla, your turn!
You have 1 cards
The center card is 2, Yellow.
Select your option
0 -- look card
1 -- look all cards
2 -- play card
3 -- skip
4 -- REAL HARDWARE
4
Comparing classical and quantum hardware
Job id on backend aer_simulator
Job id on backend aer_simulator
Job id on backend aer_simulator
Job id on backend aer_simulator
Job id on backend aer_simulator
Job id on backend aer_simulator
Job id on backend aer_simulator
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Job id on backend aer_simulator
[0.9849374199721426, 0.9534261672573373, 0.890327362258676, 0.9185301040690768, 0.846792818107955]
Turn done

Artem broke the Jenga tower at 4-th move
Leyla is winner! Quantum Congratulations
```

Possible improvements

1) GUI
2) Adding more players
3) Special cards
4) Testing more shots of the game with constant evaluation of the process
5) Implementing quantum reinforced learning for improving the game model and subsequently minimizing noise of IonQ
6) Improve complexity of the game rules

Thank you!