

01.

Forecasting Turnip Prices
with the Bayesian network
using Qiskit

mutQoin

2021.02.19

Teammate

Jungyeon Lee @curieuxjy

Juon Kim @rkfqs13

SeokMin Yun @alchemist3495

Jungu Cho @jojoon99

*all of the team in Flipped_14th_QMLQC in modulabs



Coach

Aeyoung Kim @bluesein

Soyoung Shin @Sophy

Junye Huang @Junye

Index

THE CONTENTS

- ✓ How turnips work in Animal Crossing
- ✓ Our solution : mutQoin
- ✓ Demo webpage
- ✓ Bayesian network
- ✓ mutQoin development
- ✓ Results
- ✓ Conclusion & Future work

How turnips work in Animal Crossing

03.

RULES FOR TRANSACTIONS OF TURNIPS

- In every Sunday morning, you can buy turnips from Daisy Mae
- Sell turnips to Tommy in the other days except Sunday
 - 2 separate turnip prices a day(am/pm)
- If you don't sell the turnips by the next Sunday, they'll be worthless
- 4 Patterns of turnip prices provided by the official guide on a daily basis



Buy turnips!

Sell turnips!



Could we predict the turnip price?

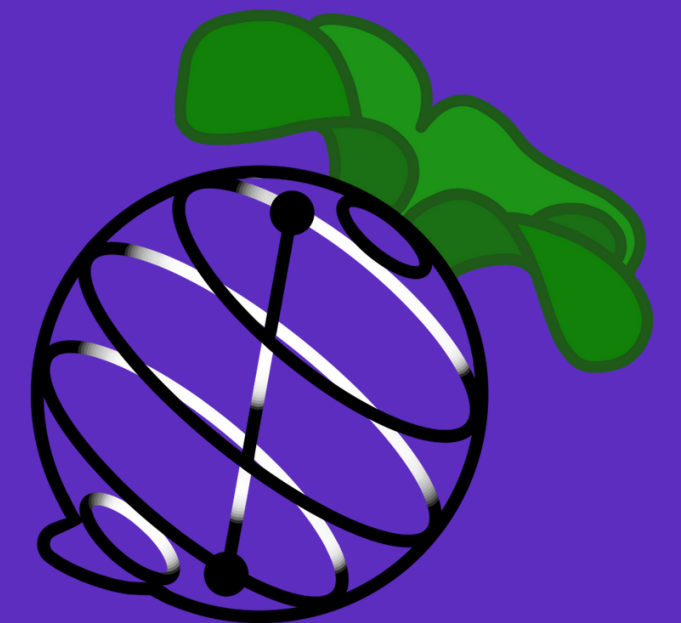
Then, we can make the BEST profits!

Motivation

- There is no prediction model using quantum supremacy
 - The original prediction service in communities : mutCoin
 - "mu" is the korean name of a turnip
 - "mutCoin" pronunciation is similar to bitcoin
- The training data of turnip prices is very small

Our solution : mutQoin

- mutQoin
 - using Quantum computing : $C \rightarrow Q$
- 2 process
 - predict the next price of turnips
 - predict the patterns up to next time



Forecasting Turnip Prices
with Bayesian network
using Qiskit

Demo Webpage

<https://mqcalc.run.goorm.io/>

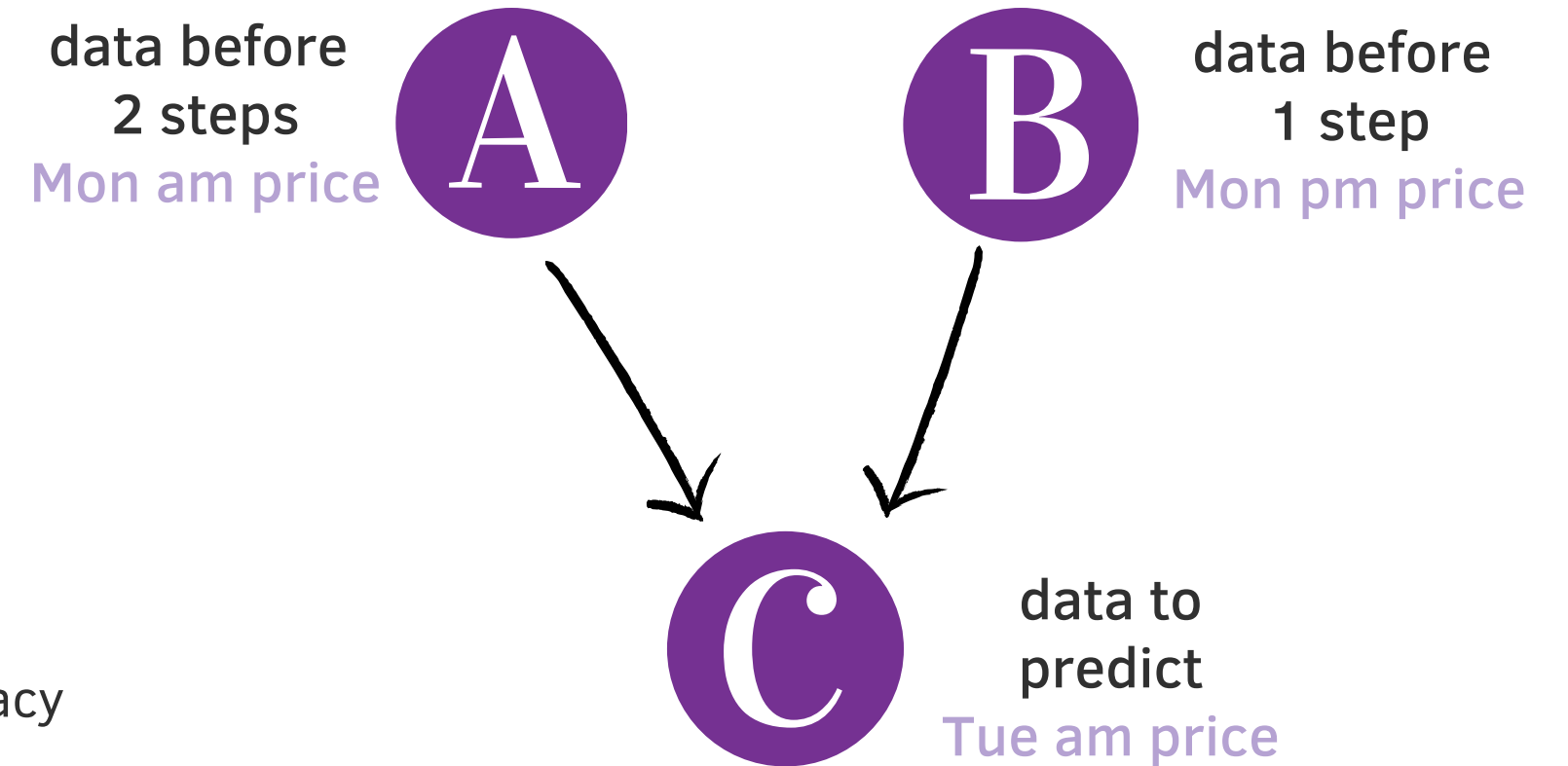
Bayesian network

06

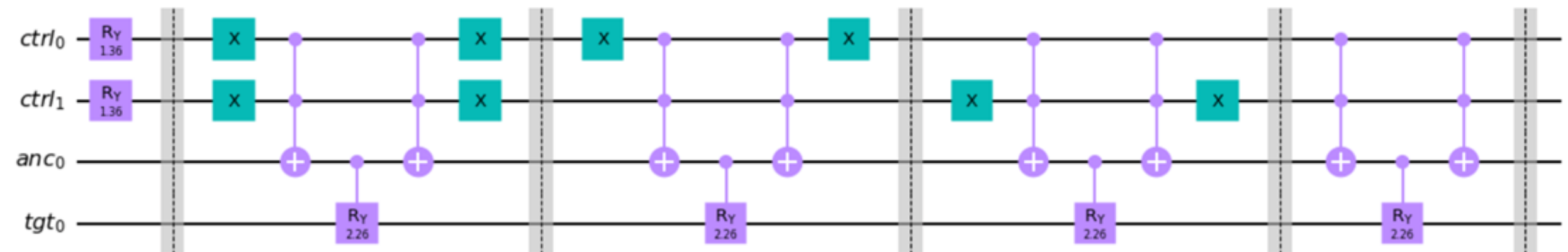
- ✓ Parents - two previous data / Child - predicted data

WHY PARENTS=2?

- The most basic model parameters of the Bayesian network
- 2 problems with increasing parents
 - limitation of the number of the qubit
 - Difficult to map changed Bayesian models to a set quantum circuit
- Also, parents=2 prediction accuracy is high !
- So, fixed "parents=2" and changed the simulator to improve the accuracy

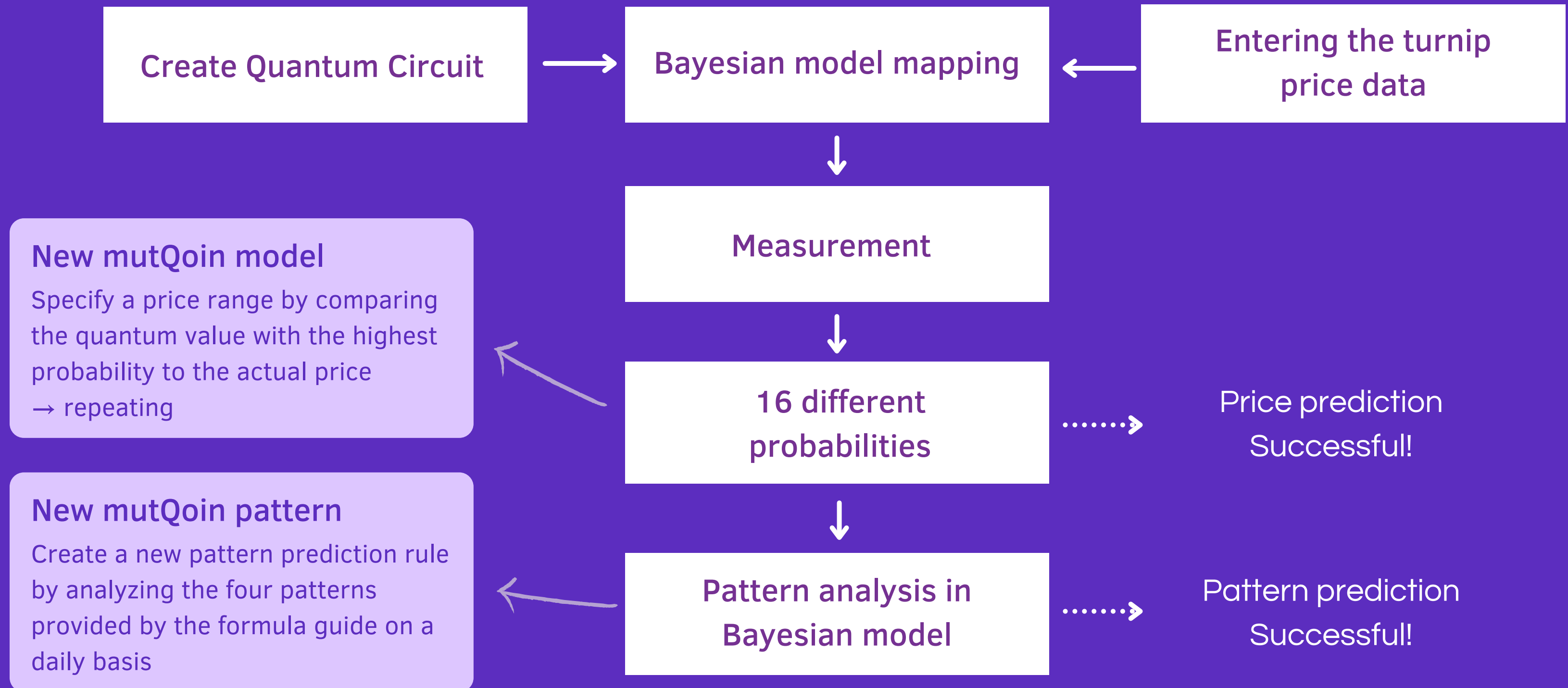


Bayesian network
mapped quantum circuit



07.

Overview of mutQoin



New mutQoin model

08.

✓ How to

Specify a price range comparing the quantum value with the highest value with the highest probability to the actual price

3/30 am & 3/30 pm -> 1000 (real:101)
3/30 pm & 3/31 am -> 1011 (real:157)
3/31 am & 3/31 pm -> 1011 (real:158)
3/31 pm & 4/1 am -> 1011 (real:156)
4/1 am & 4/1 pm -> 0001 (real:48)
4/1 pm & 4/2 am -> 0010 (real:43)
4/2 am & 4/2 pm -> 0010 (real:38)
4/2 pm & 4/3 am -> 0001 (real:34)
4/3 am & 4/3 pm -> 0001 (real:30)
4/3 pm & 4/4 am -> 0001 (real:26)

→
repetitive
training

0000 : below 20
0001 : 21-40
0010 : 41-60
0011 : 61-80
1000 : 81-100
1001 : 101-120
1010 : 121-140
1011 : over 141



The next price is expected to be between 81 and 100.

Price prediction
successful!

New mutQoin pattern

09.

✓ How to

Create a new pattern prediction rule by analyzing the four patterns

Pattern	Ratio of price forecast to previous price
Up down up down	90%~140% -> 20%~90% -> 110%~180% -> 20%~90% -> 110%~180%
Big spike	85%~90% -> 100%~155% -> 160%~610% -> -360%~100% -> -60%~50%
Decreasing	85%~90%
Small spike	40%~90% -> 100%~200% -> 100%~210% -> -60%~50%

Up-down-up-down

Big Spike

Decreasing

Small Spike



---> Up down up down pattern
The price will increase in the future.

Pattern prediction
successful!

10.

Results

- Comparison Between the original mutCoin and mutQoin

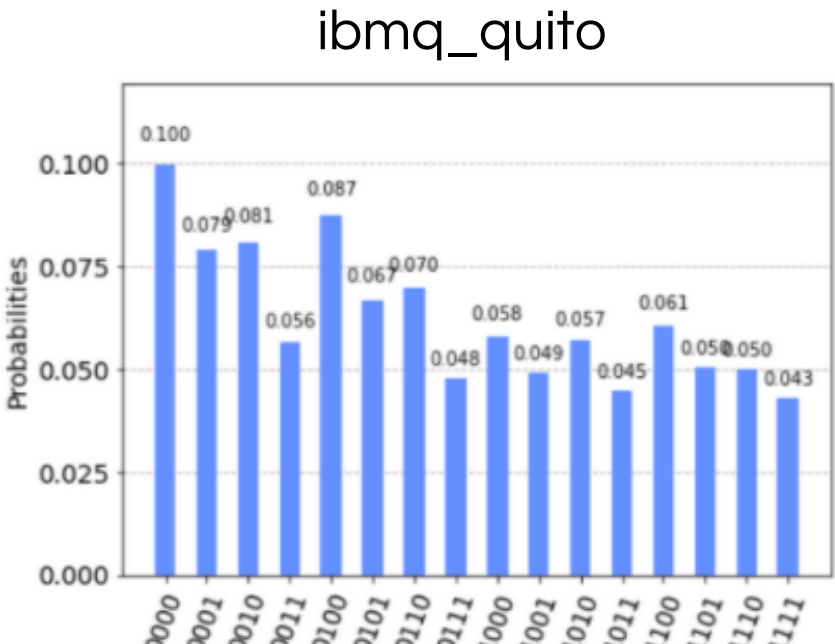
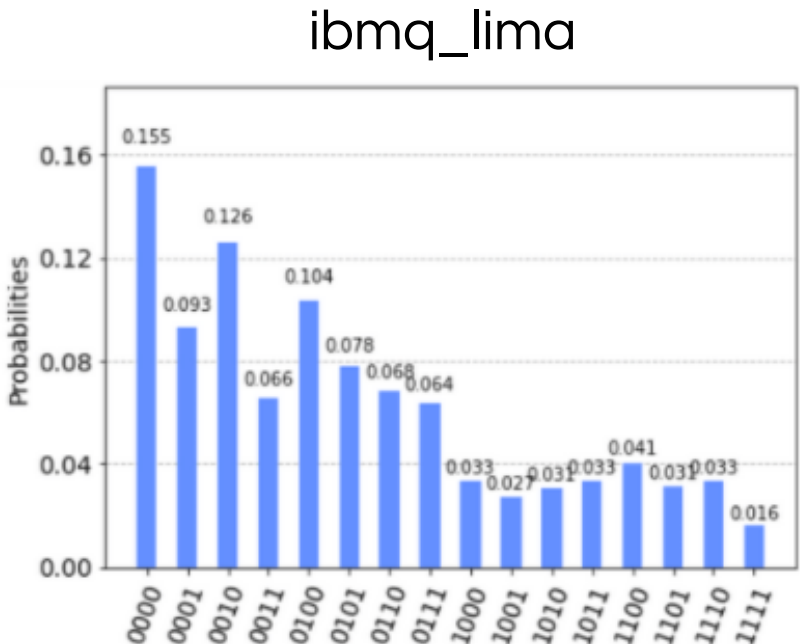
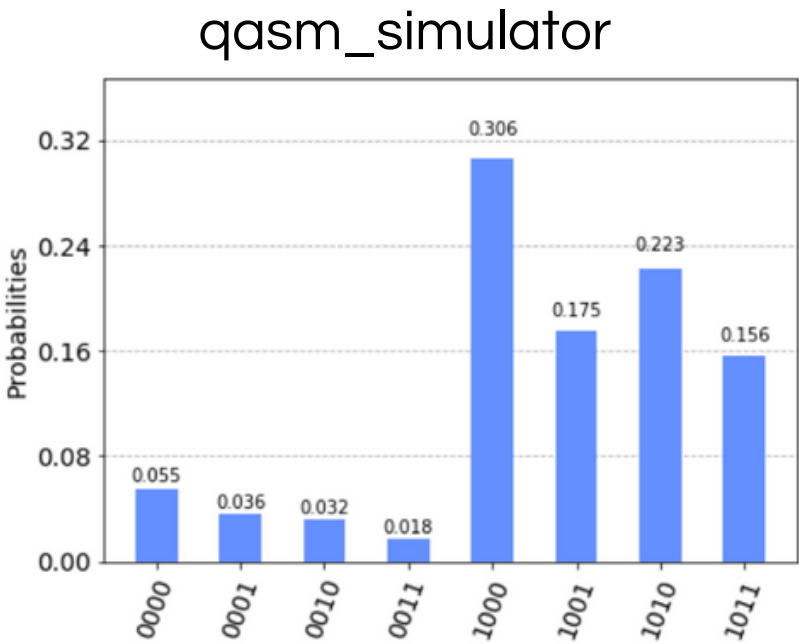
mutQoin	Existing predictors
Predictable with less data	Cumulative data required to predict
Calculate probabilities at once using superposition	Calculate probabilities one by one

Results

- Comparison between computing resources

qasm_simulator	ibmq_lima & qito
High speed	Low speed
Little noise	A lot of noise

	original circuit	transpiled circuit	
		optimization level=1	optimization level=2
depth	20	136	128



12.

Conclusion & Future work

EXPECTATION EFFECTIVENESS

- Using only the previous 2 data, both price and pattern can be predicted
- Available at high speeds
- Can be expanded from turnip price to predict stock price

IMPROVEMENT

- Increase accuracy
 - use more shots
 - try different Bayesian network design
 - another matching price table(model parameters)
- Make the model robust to noise

WHAT WE LEARNED...

- Opportunity to better understand Qiskit
- Chance to get feedback and comments from good mentors
- Very intensive and impressive group working
- Make an interesting application using Quantum

Acknowledgement

SPECIAL THANKS TO

- Aeyoung Kim (Hanshin University, Professor, Persil in Flipped_14th <QC for QML> in modulab, @bluesein)
- Soyoung Shin (Seoul National University, IBM, Qiskit Advocate, @Sophy)
- Junye Huang (IBM, Developer, @Junye)

THANKS TO

- byskit (<https://sebastianorbell.co.uk/byskit.html>)
- Flipped_14th <QC for QML> in modulab (<https://home.modulabs.co.kr/product/14th-introduction-to-qc-for-understanding-qml-part1/>)
- Qiskit Hackathon Korea (<https://www.hackerearth.com/challenges/hackathon/qiskit-hackathon-korea/>)

TEAM MEMBERS

- Jungyeon Lee (Hongik University, Undergraduate student, @curieuxjy)
- Juon Kim (Ewha University, Undergraduate student @rkfqns13)
- SeokMin Yun (Hanshin University, Researcher, @alchemist3495)
- Jungu Cho (CJ olivenetworks Developer, @jojoon99)

Thank you for listening Questions

If you want to see more details about our project,
<https://github.com/mutQoin/mutQoin>