Lab 2 Report

Applications of Quantum Information Processing

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Q1[1]

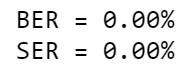
(a)

alice\_bits = [0,0,0,1]

if we use the qasm\_simulator, bob\_bits will always identify with alice\_bits [0,0,0,1]

BER = 0%

SER = 0%



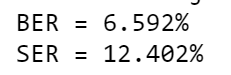
The relation between BER and SER is the same, 0%.

(b)

alice\_bits = [0,1,0,1], on real devices

BER = 6.592%

SER = 12.402%



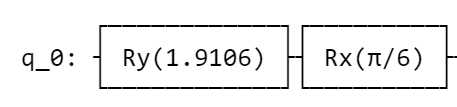
We can see that the SER is approximately twice of BER.

Using the mathematical analysis, the probability of a bit corrected transmitted is

1 BER. A system contains 2 bit string. The transmission between two bits is independent. Hence the probability of a system corrected transmitted is . , which is approximately 2BER when BER is small. For the more accurate calculation of SER = = 12.75%, which is 0.99% from the real SER. By comparison, SER = 2BER = 13.184%, which is 6.3% from the real SER.

Q2[2]

Prepare for initial state(From Lab1 1(h))



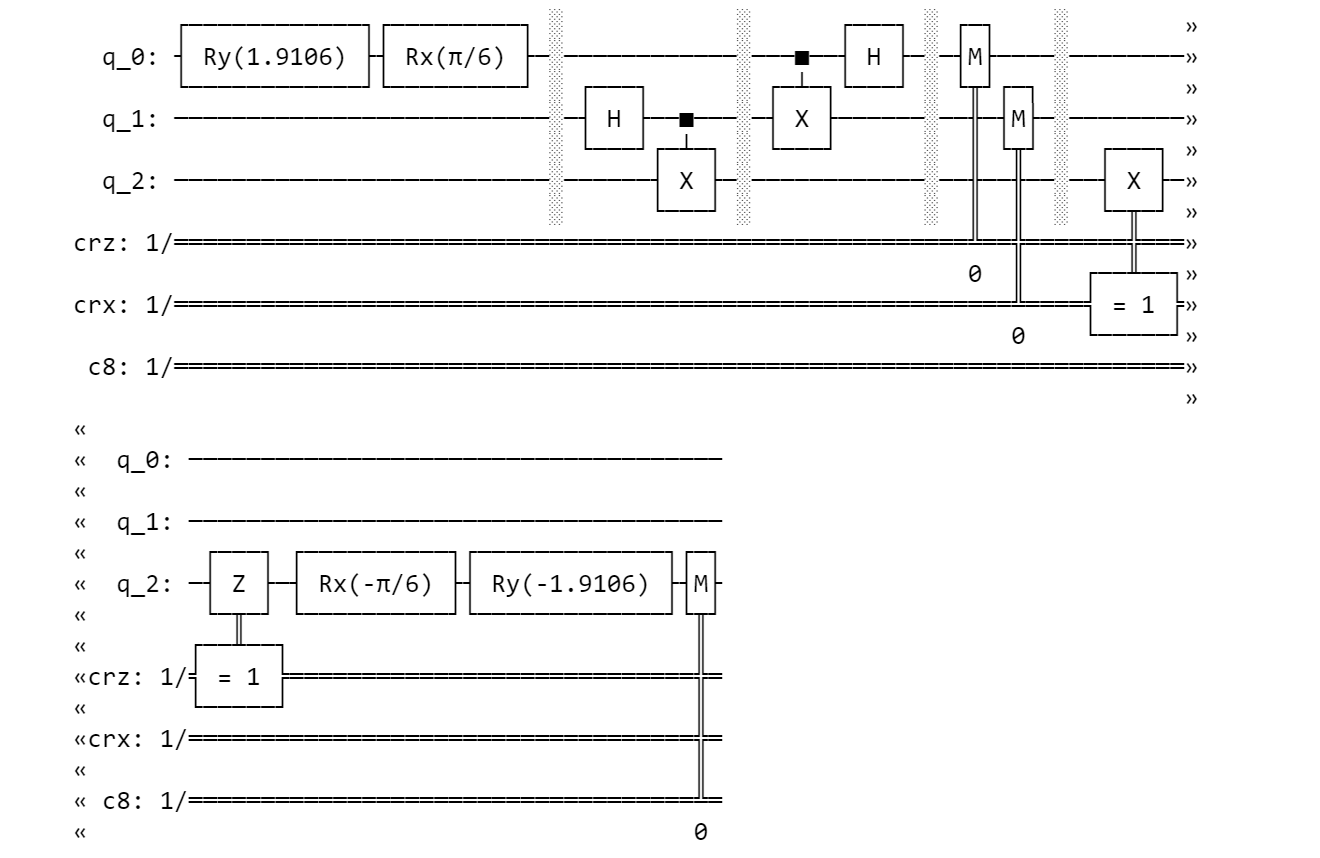
(i)

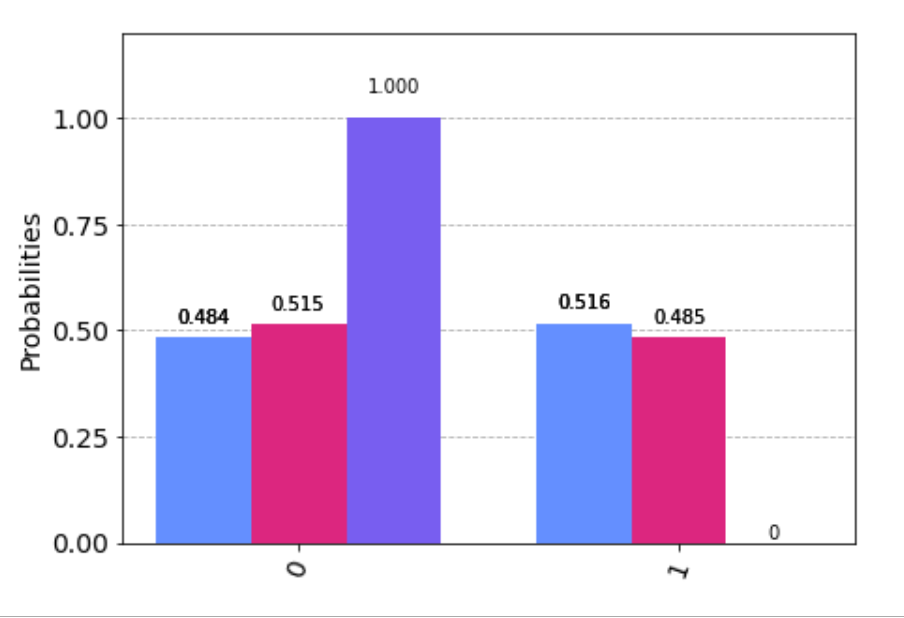
∣ψ⟩B = [0.55768−0.21132𝑖, 0.78868−0.14943𝑖]

∣ψ ′ ⟩B = [0.55768−0.21132𝑖0.78868−0.14943𝑖]

= 1

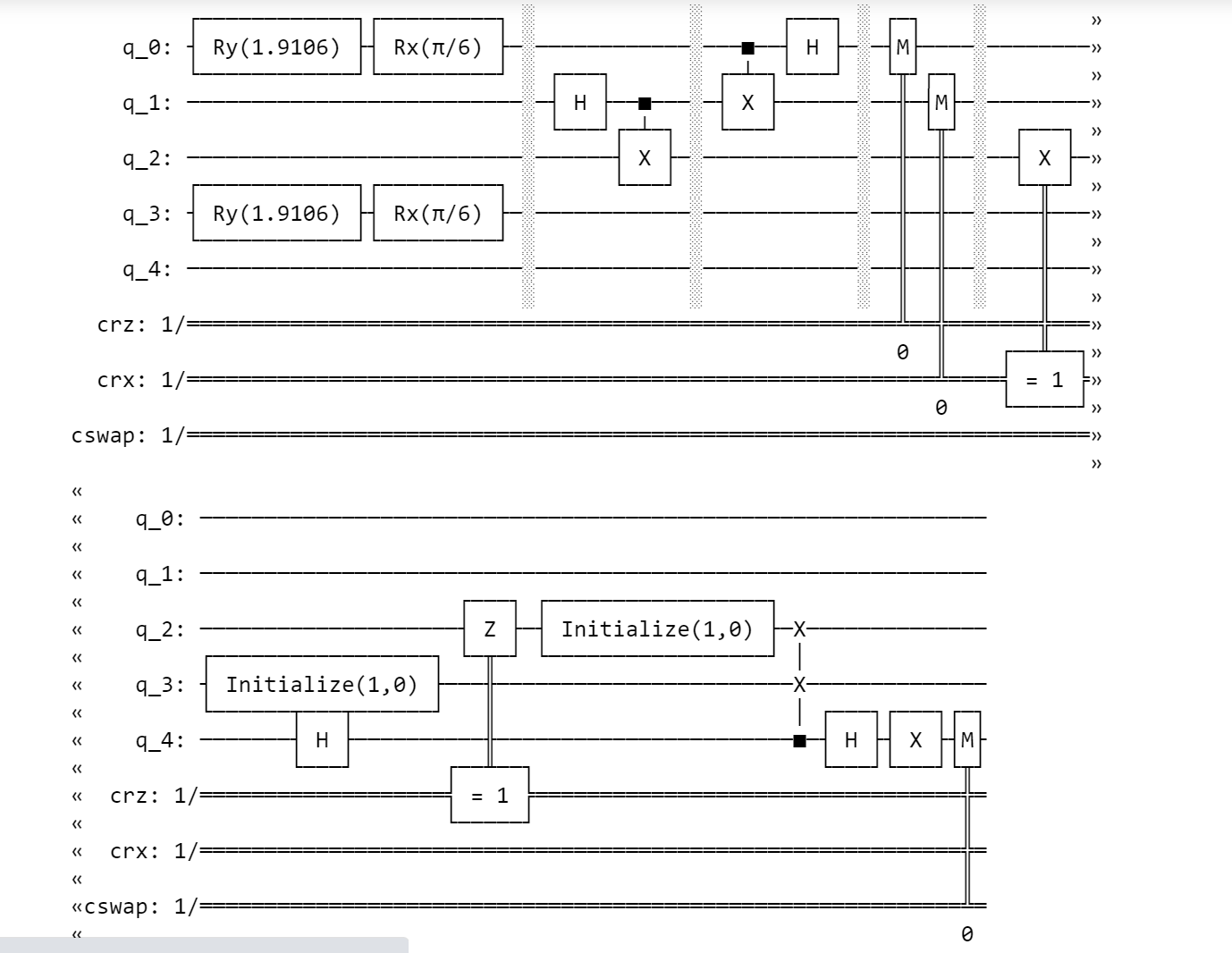
(ii)

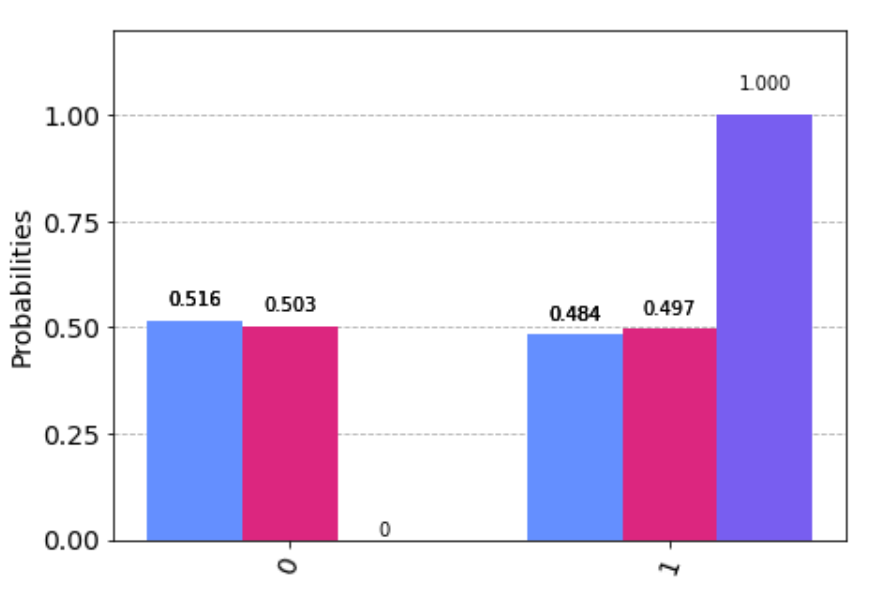




The measurement is to the third classical bit, which is 100% 0 state.

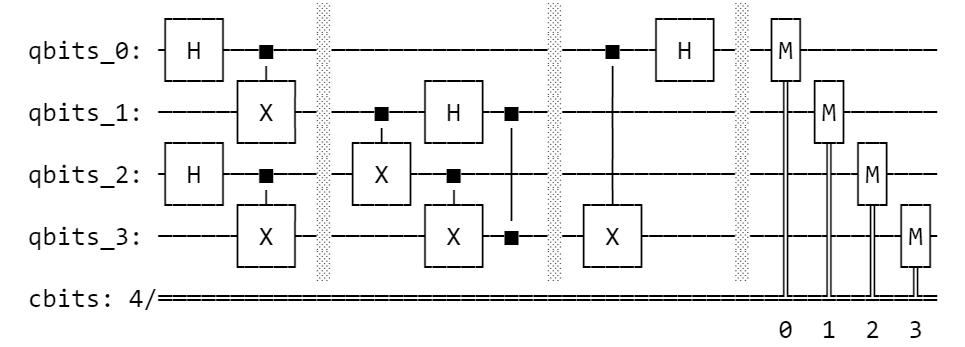
(iii)





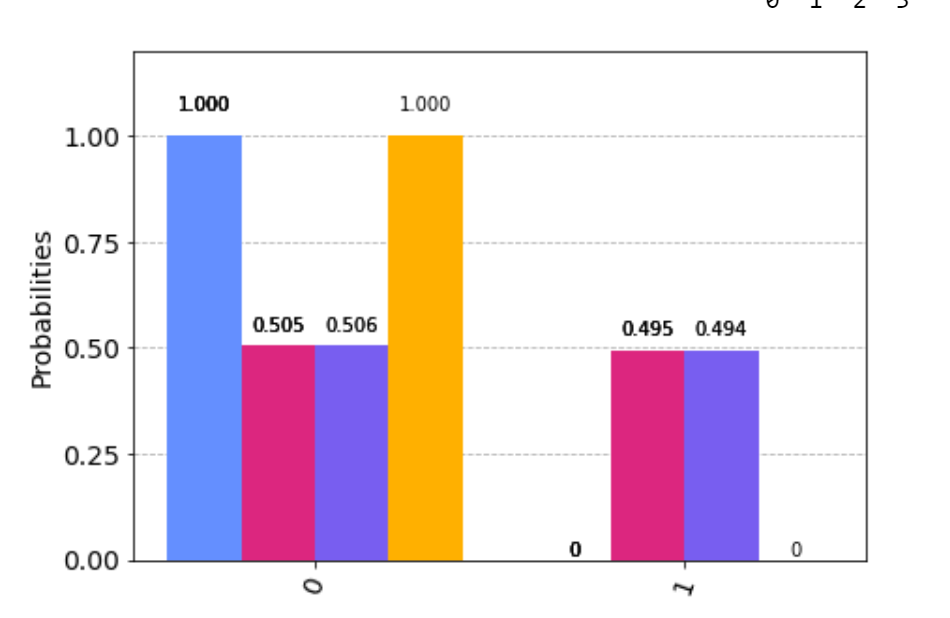
The measurement is to the third classical bit, which is 100% 1 state. The result means that the two qubit state is identical.

(b)[3]



We create a function to validate which state is |q0q3> and add the cnot gate between q[0] and q[3] and the h gate on q[0] for reversing the state to 00 state.

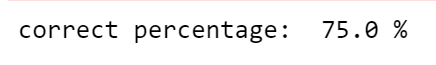
The result of |q0q3>



The result shows that the q[0] and q[3] are always 0. Hence, before reversing, we create an entangled state between Alice and Bob through Charlie.

Q3

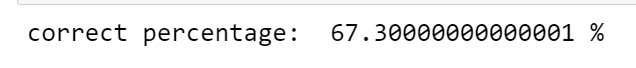
(a)



(b)



Bonus





Appendix

Code: <https://github.com/yuanchiachang/CommLab/blob/main/Lab1/src/Lab1.ipynb>

Reference :

[1] https://qiskit.org/textbook/ch-algorithms/superdense-coding.html

[2] https://qiskit.org/textbook/ch-algorithms/teleportation.html

[3] https://github.com/SowmitraDas/Quantum-Repeater-using-Quantum-Circuits/blob/main/Elements%20-%20Entanglement%20Swapping.ipynb

[4]https://qiskit.org/textbook/ch-algorithms/quantum-key-distribution.html