Quantum Generative Adversarial Network with Noise

Project Name: Quantum Generative Adversarial Network with Noise

Project member:

YmHuang
WhRen
ZlChen

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WH REN

Contents

1 Experiment

date:2020.5.24
In this week,I want to use quantum image representation to encoding an image to a pure state.But if we use a coefficient of computational basis,there have two questions.

$$c_k = F_{i,j} / \left(\sum F_{i,j}^2 \right)^{1/2}$$

First,when we usepure state to representation a big image,every coefficient would be very small.If we use a 28x28 image,the coefficient is about $c_k = 100/\left(\sum 100^2\right)^{1/2} = 1/28$.This pure state just like zero state.
Second,if we want to use this representation to represent a full zero image,it will fail to represent.
So,next week,I want to change this representation by another representation or improve it so that it can be used in our program.
date:2020.5.28
In this week,we modified the formula

$$c_k = F_{i,j} + 1/\left(\sum (F_{i,j}+1)^2\right)^{1/2}$$

,this change solved the second problem last week.
For the first problem in last week,I used two qubits to generate a 2x2 image,so that we can generate a 28x28 MINST image by 7x7 two qubits pure state.

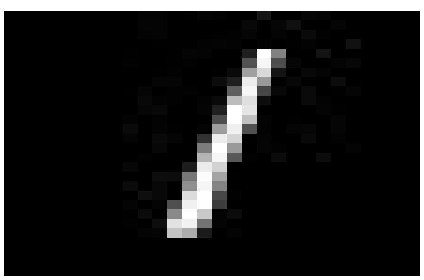
Figure 1: MINST image.

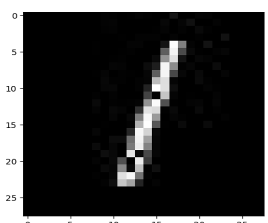

Figure 2: qGAN generate image.

Question1:
In the first test,there are a lot of block pixels in generated image.Because some pixels are more than 255.So it appears black in generated image.
Question2:
In the experiment,I found two different pure state have same amplitude and their fidelity close to 0.99,but they are completely different.The target state is $|\, t >= (0.5, 0.5, 0.5, 0.5)^T$ .The fake state state is $|\, g >= (-0.388 + 0.34j, -0.391 + 0.278j, -0.368 + 0.292j, 0.4209 + 0.325j)^T$. This don't affect generate image experiment,but it will affect the experiment that generates the pure state.
So,can we find other ways to solve this problem? Like changing other discriminating methods or distance measurement.
date:2020.6.1
In last week ,question 1 gave some block pixels in generated image.Some pixels were more than 255 when we use a fake state to approximate a target state which have a pixel near to 255.This is a approximate state,so it would have some error.This error lead to some pixels more than 255. In this week ,I'll just set a threshold when the pixel are more than 255.The threshold is equal to 255. In pictures 9 and 10,we can see the block pixels is missing.
For the question2 ,could we change the fidelity?

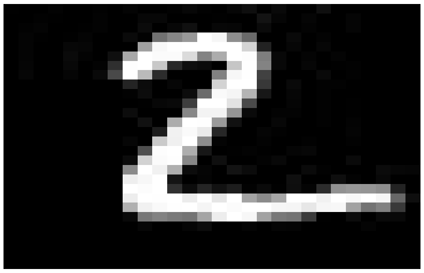

Figure 3: MINST image.

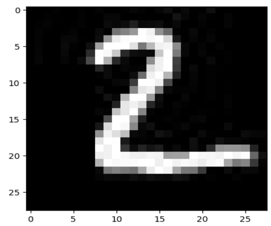

Figure 4: qGAN generate image.

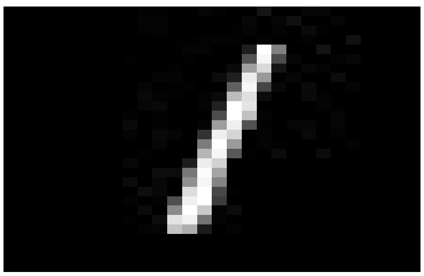

Figure 5: MINST image.

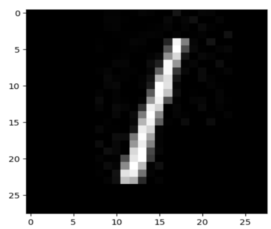

Figure 6: qGAN generate image.

2 Results

There are some repeated experiments.

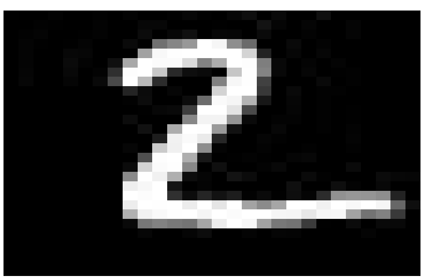

Figure 7: MINST image.

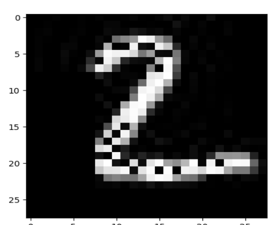

Figure 8: qGAN generate image.

3 Next Plan

P: 1 find some ideas

2 solve problems

4 Reference

References

[1] Benedetti, M., Grant, E., Wossnig, L., and Severini, S. Adversarial quantum circuit learning

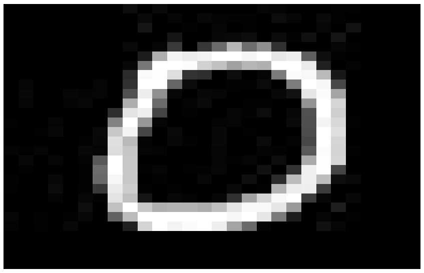

Figure 9: MINST image.

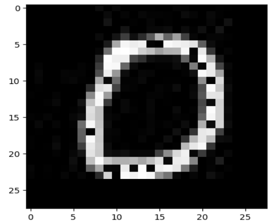

Figure 10: qGAN generate image.

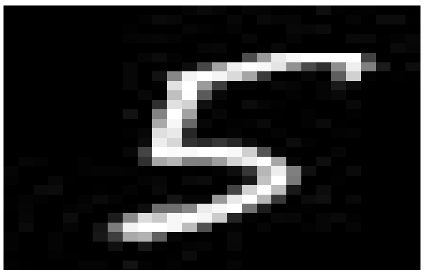

Figure 11: MINST image.

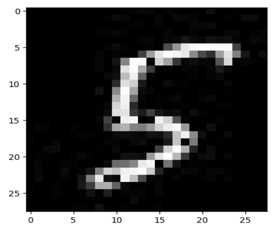

Figure 12: qGAN generate image.

for pure state approximation. *New Journal of Physics 21*, 4 (2019), 043023.

[2] Shende, V. V., Markov, I. L., and Bullock, S. S. Minimal universal two-qubit controlled-not-based circuits. *Physical Review A 69*, 6 (2004), 062321.

5 Appendix

A Source Code

just add core codes