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Report: Impact of noise in amplitude amplification on IBM Q
Reviewer/Opponent: Emilia Rieschel
Date: 2022-05-26

Provide a concise summary of the research presented in the report

Environmental noise is a big problem regarding the usage of quantum computers. One suggested strategy to solve this problem is using error-correcting codes. However, to efficiently make use of error-correcting codes, it is important to understand the mapping of noise to errors in quantum computation. This is what the report investigates, specifically by investigating how a quantum algorithm changes behavior depending on the noise.

They do this by simulating diffusion, which is a central operation in Grover's algorithm,which is the algorithm chosen to investigate in this report.

The results presented in this report are inconclusive, and the research questions cannot be answered. However, the results are in line with previous research in that errors in even five qubit circuits degenerate the results to the point where they are unusable.

Title and abstract

Regarding the title, I think it is good, however maybe change IBM Q to what it is instead. So for example, changing the title to "Impact of noise in amplitude amplification on a quantum computer", or something similar.

I think the abstract is good and summarizes the report well. However, in your title you say amplitude amplification, and that is not mentioned at all in the abstract. To make it more clear for the reader, maybe mention that at least once in the abstract as well.

Introduction – problem statement

You have a yes or no question which our supervisor has told us to not have. So maybe change it to: "How does the … vary under different models of noise" in order to have a more interesting answer.

Personally I also think it is best to not use brackets in the research question, so I suggest removing the brackets and adding a comma instead.

Maybe make the second question a bit more specific (conditions can be more or less anything if not more specified), especially writing that it still is regarding the Grover's algorithm.

In the first research question you say significantly vary. What do you mean with significantly? And if you use it, should you not measure it with a statistical significance test?

Otherwise I think the research questions are clear!

From the background, you clearly understand how error-correcting codes relate to noise. However, it feels like the quantum algorithm Grover's search algorithm comes out of thin air. I therefore think it would be great to also talk more specifically about quantum algorithms already in the introduction, and motivate more about why it is interesting to investigate the behavior of the algorithm. Otherwise I think the background works great!

Background information and related work (state of the art)

You are using a lot of brackets in the background. I suggest replacing at least most of them with commas, or just deleting the brackets.

It seems that sources are missing at a lot of places, so please double check that again.

I think the background is coherent and relevant to the project. However, it of course depends on what you will write more in the result and discussion.

Methods

To figure 3.1 you should probably add to the description what the squares with H and X is.

Maybe add a description to how you calculate the mean square error.

Why did the diffusers have the sizes 2,3 and 5?

The title noise profiles has a spelling mistake now. It says nosie profiles.

I also think it would be great if you explain the noise profiles to a greater extent. What does the different noise profiles mean? I see that you have explained the first two, which is great! But as a reader, I would also like to know more about your custom noise profiles.

Otherwise I think your method is clearly described.

Results (objective observations)

Since you are not done with the results it is hard to give proper feedback.

However, I think you will not need the last table. It will be enough with figures that you create from those values and mention your MSE value. The table can then be in the appendix.

The figures need to be made more clear. It is now rotated 90 degrees and the text is really small. So make sure that the text is not rotated, and that it is big enough for the reader to see everything clearly. I understand that it will probably not fit on the page if you rotate it, but maybe it is possible to divide it in half? Or if you can visualize the data in some other way so that the figure fits.

Make sure also to add text in the results where you comment your figures.

Really good with a heat map! That makes it easy for the reader to understand the result!

Discussion and conclusions (subjective analysis and perspective)

The beginning of the discussion should be in results, since you are only describing the figures.

The conclusion as it is now is not directly answering the research question. In the conclusion you talk about that the type of quantum error matters little, but the research question is: Do the results of Grover's algorithm significantly vary under different models of noise?. So the conclusion and research questions could be clearer connected.

You could earlier have written about your assumptions, and then you can write in the discussion if the results were as you assumed and then why/why not.

Maybe add what kind of implications your result give. If the type of quantum error matters little with regards to the uniformity of the resulting distribution, what would that imply?

Otherwise I think you include everything. You discuss your results, the limitations and future work.

Overall characteristics (coherence, presentation style, structure, language)

The figures and tables should be more easily interpreted, and also described to a greater extent.

The language is good, but the brackets are disturbing for the reader. These should be removed.

Regarding that the content is coherent with the research question I believe it is, but it can be made more clear. First of all, make sure that the conclusion answers the research question. I was also confused regarding the title which mentioned amplitude amplification because it was not mentioned at all in the abstract or introduction.

Otherwise I think the coherence, presentation style, structure and language is overall good.

In summary, what was your overall reception of the report (balance positive and negative remarks – point out both weaknesses and strengths)? What are your recommendations for improvement?

In summary I think you have done a good job. It is an interesting subject, and I think you explain it well to the reader.

However, I needed to read the report several times to completely understand the aim, research question and how the discussion and conclusion connected to it. So I recommend you to make that a bit more clear. Also as I said, it is a bit confusing that you focus so much on one algorithm, but do not motivate why or write about quantum algorithms at all in the introduction.

Regarding that you have chosen the Grover's algorithm. It would be interesting for the reader if you write for example in the discussion if the results that you have got can be generalized for other algorithms as well, or if it is only specific for the Grover's algorithm.

Otherwise I think it is a good report, especially the explanations in the background and the overall structure of the report.

Other:

- Maybe oracle functions is something that should be explained? Since it is mentioned several times.
- Our supervisor said that acknowledgement should be on its own page directly after the contents.