PHYS4041 (2022-2023)
**An introduction to practical quantum computing**
PROJECTS
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As the assessment for the module, you are required to write a short paper in the format of a 2-column scientific journal article. You should write the paper using latex and the revtex package for formatting that follows the style of APS journals. Your project will be undertaken as part of a group and your paper should have 2-3 pages. Make sure to divide the work evenly! You should write a single paper as a group, but all members of the group should submit the paper, any accompanying code, and a statement on their involvement in the project.

As a guide, the paper should have (but is not restricted to) the following elements / structure:

1. Title
2. Author list
3. Abstract
4. Introduction
5. Setup of the problem
6. Results and discussion
7. Conclusion and outlook
8. Bibliography

Below are several possible projects for you to choose from, which you will be able to submit on Moodle. Based on your choices you will be put into groups. I will arrange group meetings with you to happen in our normal 9am slot on Fridays. All of the projects include the same steps but in different settings. Whatever project you choose, you will be tested on the same skills, but you may find a particular setting more interesting.

Note: it would be great to have something run on the real IBM devices. However, I am aware that running on the quantum computers takes a significant amount of time and can be a bit problematic. Since it amounts to a change of a few lines of code you will not be marked down if this can't be achieved during the project. With that said, performing such experiments provides a natural chance to discuss the realities of working with current noisy quantum computers (but you could introduce this anyway), which can lead to a stronger discussion in your paper.

**PROJECT 3: Quantum generative adversarial network.**

In this project we will create a quantum circuit to generate handwritten digits, trained using the MNIST dataset. The approach for generating these images will be to use Generative Adversarial Networks consisting of a quantum generator and a classical discriminator.

**Main tasks**

1. Write code to implement Quantum GAN, based on `https://pennylane.ai/qml/demos/tutorial_quantum_gans/`
2. Investigate generating different digits
3. Investigate different methods for patching
4. Investigate different circuit structures
5. Compare different methods for computing (or approximating) gradients

**Further investigation**

1. Generate Fashion MNIST instead of MNIST handwritten digits.
2. Run an optimised circuit on IBM device