Introduction to Quantum Computing
Assignment – Quantum Walk

Due: Friday, 08 November 2024 by 12:00

This assignment counts for **25% of the course**. All questions for are available in the Jupyter notebook (`iqc24-cw.ipynb` file) shared together with this document. You should answer each question both by adding Python code to the code block, and writing comments in the markdown block right below the exercises. The code blocks already have some example code provided, but these are just suggestions, and feel free to modify them – as long as you follow the instructions, you can get full marks. The weights of each question and sub-question are given (amount of marks), but note that this is **not** indicative of how difficult the corresponding sub-question is.

Structure

The coursework is split into three parts:

1. **Part 1 – classical random walk**. This is an introduction to random walks. Exercise 1 asks you to implement a linear-algebra-based random walk with boundary conditions.

2. **Part 2 – quantum walk in 1D**. Here, you are asked to gradually built up a quantum walk, from exercise 2 to exercise 4. Finally, in exercise 5 you are supposed to come up with an algorithm for classical walk on a quantum computer.

3. **Part 3 – quantum walk in 2D**. This is similar to part 2, but your task is to implement a 2-dimensional version of the quantum walk. This part has exercises 6 and 7, which are less detailed, and you are expected to come up with the code structure yourself.

Note that as much as you should follow the exercises in order to build your intuition and understanding, you might prefer to skip certain parts for later. You can get a total of **100 marks**.

Setup

The Jupyter notebook file has instructions on how to set up the Python environment. Make sure to use a clean environment, as this is what your code will be run on. The Python version used to design the exercises was `3.12.6`. The packages used are `matplotlib`, `numpy`, and `pennylane`. Please do not import any other packages.

Submission

Submit the Jupyter notebook file with the filename `iqc24-cw-<your-exam-number>.ipynb`.

Important message:

Please remember the good scholarly practice requirements of the University regarding work for credit. You can find guidance at the School page, `http://web.inf.ed.ac.uk/infweb/admin/policies/academic-misconduct`. This also has links to the relevant University pages.