Final project

Ana Neri

November 29

1 Work description

The fundamental objectives of this work are the analysis of quantum computing tools and the implementation of quantum programs, using techniques learned in the practical classes. The projects should be carried out in groups of two students. Each group may choose a topic from the list in Section 2, or propose one, and when applicable implement corresponding algorithms. Each group must write an **essay** on the topic chosen and a **Qiskit script**. The essay should preferably be in English and follow the structure of an article/experimental report

Each work should contain (and will be evaluated on) the following elements:

1. *Introduction* - each work should start by describing the problem to be addressed and any known quantum techniques/subroutines involved.

2. *Materials and methods* - for instance, any algorithm should be described rigorously, in mathematical terms.

3. *Implementation* - the work should provide a coded Qiskit implementation of the algorithms or programs, with distinct examples.

    - This element will be evaluated for code presentation and documentation. Points will be awarded for the implementation's ease of use and scalability.

4. *Results and discussion* - the implementation should be simulated and its results discussed.

    - Are the results as expected? If not, point to possible faults in the implementation, algorithm or hardware limitations.
    - What future work may be developed from the implementation?

2 Suggested topics

1. Quantum chemistry
   - A Full Quantum Eigensolver for Quantum Chemistry Simulations
2. Quantum Artificial Intelligence
   - Image Classification via Quantum Machine Learning
3. Quantum computing for finances
   - A More General Quantum Credit Risk Analysis Framework
4. Quantum error correction (e.g. surface codes)
   - Scalable Quantum Circuit and Control for a Superconducting Surface Code
5. Variational methods
   - Variational Quantum Circuits to Prepare Low Energy Symmetry States
6. Game theory
   - The Game Theory in Quantum Computers: A Review
7. Quantum walks
   - Quantum algorithm for de novo DNA sequence assembly based on quantum walks on graphs
8. Graph problem
   - Solving Vehicle Routing Problem Using Quantum Approximate Optimization Algorithm
9. Optimisation problem
   - Quantum Minimum Searching Algorithm and Circuit Implementation

3 Submission instructions and defence

Indicate who the **members of the group** are and what **topic** you have chosen until **December 21 at 11:59 pm**.

Submit the **report and the jupyter notebook** until **Monday, January 8, 2024, at 23:59** to ana.i.neri@inesctec.pt.

You will have **15 min for your work defence**, this includes your presentation (10 minutes) and questions (5 minutes). It will happen on **Friday, January 12, 2024**.

Any questions contact: ana.i.neri@inesctec.pt