

Quantum Computing @ MEF

Assignment

Luís Barbosa and Renato Neves

nevrenato@di.uminho.pt

This assignment is divided in two parts: one is a concrete exercise on quantum algorithmics; the other, more exploratory, consists of writing an essay on a topic of Quantum Computing. We detail each of the two parts next.

1 Exercise on Quantum Counting

In a previous homework we studied Grover's algorithm as a way of tackling the *Satisfiability problem* [ST13]. In particular, we saw that the algorithm allows to *compute the solutions* of a Boolean formula, such as $\varphi = A \wedge (\neg B \vee C)$. Note, however, that if one is only concerned with satisfiability it is unnecessary to compute solutions and it may be better instead to *only* determine whether there exists a solution.

Therefore your next task is to use the *Quantum Counting algorithm* [NC16] to compute the number of solutions of φ (rather than the solutions themselves) and present the corresponding circuit in Qiskit.

2 Essay on a topic of Quantum Computing

Write an essay (around 8 pages) on one of the following topics:

- Error correction;
- Circuit optimization;
- Variational methods;
- Existing quantum programming languages and respective tools;
- Quantum chemistry;
- Quantum machine learning;
- Quantum computing for finance;
- Quantum Turing machines and other quantum automata;
- Adiabatic quantum computing;
- Measurement-based quantum computing;

- Quantum tomography.

N.B. This essay will be presented to the class later on.

What to submit: A report in PDF about Section 1 and respective implementation(s) in `Qiskit`. A report in PDF about Section 2.

Please send by email (`nevrenato@di.uminho.pt`) a unique zip file with the name “qc2122-N.zip”, where “N” is your student number. The subject of the email should be “qc2122 N TPC-2”.

References

- [NC16] Michael A. Nielsen and Isaac L. Chuang. *Quantum Computation and Quantum Information (10th Anniversary edition)*. Cambridge University Press, 2016.
- [ST13] Uwe Schöning and Jacobo Torán. *The Satisfiability Problem: Algorithms and Analyses*, volume 3. Lehmanns Media, 2013.