Quantum Processes and Computation

Assignment 13, Wednesday, May 22, 2019

Exercise teachers:
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Handing in your answers: There are two options:

1. Deliver a hard copy to the mailbox of John van de Wetering. Mercator 1, 3rd floor.
2. E-mail a PDF to wetering@cs.ru.nl. Please include your name and the exercise number in the filename, e.g. ACHTERNAAM-qpc-exercise1.pdf.

Deadline: Tuesday, May 28, 12:00

Goals: After completing this exercise sheet you are aware of a number of different quantum algorithms that exist in the literature.
Material covered in book: section 12.2

The exercise sheet this week is a bit different from the usual. The goal is to make you a bit more familiar with the sorts of quantum algorithms that exist.

Exercise 1 (100 points): Go to the page https://quantumalgorithmzoo.org/ and pick two algorithms from two separate categories (those categories being Algebraic & Number Theoretic, Oracular, and Approximation and Simulation), that haven't been discussed in the lectures (so you can pick anything except Deutsch-Jozsa, Factoring (Shor), Search (Grover) and Abelian Hidden Subgroup). Alternatively you may also browse the internet and find quantum algorithms that aren't (yet) in the list. For each of the two algorithms, do the following:

(i) Describe in your own words the problem that is solved.

(ii) Describe in your own words why this is an interesting problem to solve.

(iii) Find out how hard this problem is to solve classically, and how much the quantum algorithm helps, e.g. give the time-complexities of both approaches. Is it a polynomial or exponential speed-up? You can also list improvements made to the algorithm over time here.

(iv) Give a high-level overview of how the quantum algorithm works. For instance, whether it uses a trick similar to that of Grover's algorithm, or if it uses the Quantum Fourier Transform or Hidden Subgroup Problem. Or does it use a completely different technique?

(v) **Optional**: If there is anything else you found peculiar about the algorithm you can state so here. Does it have odd restrictions or caveats? Does it only work for very particular instances of the problem? Any other thoughts?

Note 1: Every algorithm on the website has multiple references associated with it. You can follow those references to figure out more details about the papers.
Note 2: If there are multiple quantum algorithms that solve the same problem, pick just one to analyse, but you can make some comparisons to the other approaches in your answer.
Note 3: The complete set of answers for each algorithm should be about half a page.