Computer Science 750 (2019)

Assignment 2

This assignment is worth 40 marks representing 7.5% of your total course grade.

Due date: 22 September 2019, before 23.50 in Canvas

Name:

ID:

Questions

1. Compare the de-quantisation of the Deutsch's problem discussed in class with the one described in the paper D. Collins, K. W. Kim, and W. C. Holton. Deutsch-Jozsa algorithm as a test of quantum computation, *Phys. Rev. A* 58, R1633-R1636 (1998).

   [20 marks]

2. Choose one of the following questions (A) or (B):

   (A) Use IBM quantum simulator
   `https://quantum-computing.ibm.com/login`
   to program the square-root of NOT circuit. **[10 marks]**

   Justify your implementation. **[10 marks]**

   (B) Given an undirected graph $G = (V, E)$, a proper 2-colouring of G is a partition of V into two subsets V_1 and V_2 such that for all $\{i, j\} \in E$ either $i \in V_1$ and $j \in V_2$ or $i \in V_2$ and $j \in V_1$.

   Consider the following problem:

   The 2-Colouring Problem:

   Instance: Graph $G = (V, E)$.
   Question: Find a proper 2-colouring of G if one exists.

   1. Write a QUBO formulation for the 2-Colouring Problem and try to minimise the number of variables and/or the density of the QUBO matrix. **[6 marks]**

   2. Write a program for solving the 2-Colouring Problem with the D-Wave simulator. **[4 marks]**

   3. Run the program on the D-Wave simulator for an instance of a graph with 5 vertices. **[2 marks]**

   4. Write a program for solving the 2-Colouring Problem with the exact solver. **[4 marks]**

   5. Run the exact solver program for the same instance as in 3 above. **[2 marks]**

   6. Propose three metrics to compare the performances of the simulator and exact solver and use them for the solutions obtained at 3 and 5. **[2 marks]**