COL872
Lecture Reviews

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1 Lecture 13

- When introducing quantum oracle (first section on page 70), it would be helpful if an intuition can be given as to why the oracle is defined this way (and why it is defined as a unitary; why it is not defined as a unitary followed by some measurement).
- Although the equivalence between standard oracle and phase oracle was given in the assignment (for a single bit output and assuming that the second register is $|-\rangle$), it would be great if the generic version of the same can also be stated after introducing the phase-kickback trick on page 71 (PS: when reading Zhandry's paper, even though the transformation is trivial, it took us a little bit of time to think of and interpret the proof/transformation - partly because the extension from the single bit to multi-bit version involves a dot product which is not directly apparent in the case of a single bit output).
- I feel that it would be helpful to include a short discussion on the difference (or similarity) between the computational complexity of a single query in both the classical and quantum settings (and whether comparing the number of queries is enough to determine more efficient algorithms).
- "If f is a constant function, then this state is either $|+\rangle^{\otimes n}$ or $-|+\rangle^{\otimes n}$" (page 72)

2 Lecture 14

- Isn't necessary, but it might be a good idea to state that no classical algorithm can do better than $\Theta(n)$ for the 'Bernstein-Vazirani Problem' (or just state that any classical algorithm requires $\Omega(n)$ time).
- It would be better if the variable y is changed to a different variable in the definition of Simon's problem since in the later discussion y is used for output.

- The proposed quantum algorithm for Simon's problem won't work when $\mathbf{s} = 0^n$ although this is not explicitly mentioned.

- I probably missed the intuition for this, however, it took me a lot of lectures to be comfortable with easily being able to argue when quantum states are orthogonal or not. For both 'Deutsch-Josza Problem' (page 72: If f is a balanced function, then ... is orthogonal ...) and 'Simon's Problem' (page 74: Note that the only terms ... are orthogonal ...), I wasn't able to fully accept the orthogonality claimed in the notes during those lectures. It might be helpful if a short sketch of the argument is provided.

3 Lecture 16

- (a slight formatting improvement) The 'Basic Properties of Density Matrices' section has a lot of notation and hence it would be visually better if the three properties are highlighted or made bold so that they easily stand out.

- I feel that a small discussion on how to distinguish arbitrary (or special) density matrices would be helpful and would provide a helpful background in general as well as for the future lectures when we use alternating projectors.

- "Note to reviewer: is the above explanation (together with the exercise) sufficient?": The off-diagonal argument makes sense to me (under the assumption that the diagonal argument is true), however, the argument for diagonal entries isn't completely clear. Particularly, I am not sure why does the result follow from the reasoning given in brackets about 'existence of an output'. The exercise given makes the argument for off-diagonal entries clear.