

Jury Member Report – Doctor of Philosophy thesis.

Name of Candidate: Akshay Vishwanathan

PhD Program: Computational and Data Science and Engineering

Title of Thesis: On quantum approximate optimization

Supervisor: Professor Jacob Biamonte

Name of the Reviewer: Ivan Oseledets

I confirm the absence of any conflict of interest (Alternatively, Reviewer can formulate a possible conflict)	
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Date: 17-04-2023

The purpose of this report is to obtain an independent review from the members of PhD defense Jury before the thesis defense. The members of PhD defense Jury are asked to submit signed copy of the report at least 30 days prior the thesis defense. The Reviewers are asked to bring a copy of the completed report to the thesis defense and to discuss the contents of each report with each other before the thesis defense.

If the reviewers have any queries about the thesis which they wish to raise in advance, please contact the Chair of the Jury.

Reviewer's Report

The thesis is devoted to the study of Quantum Approximate Optimization Algorithm (QAOA), and how these algorithms (in the noiseless settings) will perform. Specifically, for certain problems the task is to study different performance metrics that are widely used in the literature, study the limiting performance of fixed-depth QAOA, and study folklore concentration for circuit parameters.

The thesis discovered an effect called reachability deficit, which put fundamental limitations on the performance of fixed-depth QAOA. Mathematically, it means that we minimize the quadratic form with the Hamiltonian over all possible QAOA circuit. For $p = 1$ it is shown that the gap can not be reduced by explicit maximization (hence 'the deficit'). Chapter 4 concludes with extensive numerical study of different problems (the optimization is done empirically).

Comments:

- It is good that if each chapter will end with a conclusion: what did we learn from it and why it is important. For example, Chapter 2 abruptly stops in the middle.

For QAOA optimization, empirical techniques are being used. Is there any understanding that we may - - missed some better minima and converges has been to the local optima? Will this influence some of the conclusions of the work?

-Some misprints: Schrodinger equation(p.43) is used in many places while standard notation is Schrödinger equation.

Overall, this is a very solid work based on top-level papers. There results are novel and technically correct.

Provisional Recommendation

I recommend that the candidate should defend the thesis by means of a formal thesis defense

I recommend that the candidate should defend the thesis by means of a formal thesis defense only after appropriate changes would be introduced in candidate's thesis according to the recommendations of the present report

The thesis is not acceptable and I recommend that the candidate be exempt from the formal thesis defense