

## 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:

I confirm the absence of any conflict of interest  (Alternatively, Reviewer can formulate a possible conflict)	<b>Date: 15-04-2023</b>
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*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

Reviewers report should contain the following items:

- Brief evaluation of the thesis quality and overall structure of the dissertation.
- The relevance of the topic of dissertation work to its actual content
- The relevance of the methods used in the dissertation
- The scientific significance of the results obtained and their compliance with the international level and current state of the art
- The relevance of the obtained results to applications (if applicable)
- The quality of publications
- The summary of issues to be addressed before/during the thesis defense

This thesis examines the performance of the Quantum Adiabatic Optimization Algorithm (QAOA), which is a type of variational quantum algorithm for solving combinatorial optimization problems. QAOA has attracted a lot of interest in recent years and understanding its performance is an important problem for the quantum information community. Several results regarding the performance are obtained throughout this thesis. The first and perhaps most important is the identification that QAOA has more difficulty in solving problems with a higher problem density. To overcome this, the depth of QAOA must be further increased. While this is a somewhat negative result, such results are important in understanding QAOA and has been an important result with the paper being highly cited as a result. The phenomenon of parameter concentration in QAOA, where the optimal parameters converge in the infinite qubit limit, is also defined and studied. Finally, a discussion of the circuit depth scaling is made, where an empirical relation which predicts the required circuit depth to ensure a particular accuracy with respect to the problem density. These are all high quality results that have been well received in the community. The thesis is very well written, except for a few typos. The dissertation work and methods used are relevant to the actual content. The quality of publications is excellent.

I only have a few superficial comments at this point:

- Perhaps the title of the thesis is a little too unspecific, perhaps mention something about the performance of QAOA on combinatorial optimization problems.
- In Chapter 2 discussing Ising Hamiltonians it may be nice to cite some recent approaches to solving such problems (Mohseni et al. Nature Reviews Physics, 4, p.363-379 (2022)).
- There are some typos which should be picked up with a spell checker or similar. The grammar is also not perfect, so perhaps some tool can be used to find these errors. e.g. p. 3 abstract: "sate", p.35 "it's", etc..

#### 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*