Computational Science II

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Contents

Chapter 1

Introduction

Dequantization, a process involving the presentation of classical counterparts to specific quantum machine learning (QML) algorithms with only a polynomial slowdown, raises questions about the exponential quantum advantage of QML algorithms.

The bedrock of QML, as well as its claimed advantages, hinges upon the so-called HHL algorithm developed by Harrow, Hassidim and Lloyd [2]. Notably, Aaronson [1] critiqued the HHL algorithm for its numerous 'fine print' conditions, which also impact QML algorithms influenced by the HHL approach.

Only a few years later, Tang [4] accomplished the dequantization of the quantum recommendation algorithm proposed by Kerenidis and Prakash [3], while incurring merely a polynomial slowdown. This achievement was enabled by the inherent similarities between quantum techniques like 'quantum phase estimation' and classical linear algebraic methods, such as 'ℓ^2-norm sampling through singular decmoposition'.

Bibliography

[1] Scott Aaronson. Read the fine print. *Nature Physics*, 11:291 – 293, 2015.

[2] Aram W. Harrow, Avinatan Hassidim, and Seth Lloyd. Quantum algorithm for linear systems of equations. *Phys. Rev. Lett.*, 103:150502, Oct 2009.

[3] Iordanis Kerenidis and Anupam Prakash. Quantum Recommendation Systems. In Christos H. Papadimitriou, editor, *8th Innovations in Theoretical Computer Science Conference (ITCS 2017)*, volume 67 of *Leibniz International Proceedings in Informatics (LIPIcs)*, pages 49:1–49:21, Dagstuhl, Germany, 2017. Schloss Dagstuhl–Leibniz-Zentrum fuer Informatik.

[4] Ewin Tang. A quantum-inspired classical algorithm for recommendation systems. In *Proceedings of the 51st Annual ACM SIGACT Symposium on Theory of Computing*, STOC 2019, page 217–228, New York, NY, USA, 2019. Association for Computing Machinery.