Research Proposal for Proof of Concept Implementation of Quantum Machine Learning Algorithms

Mark Fingerhuth

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In partial fulfillment of the requirements for the degree Bachelor of Science (BSc) at Maastricht University.

In collaboration with the Quantum Research Group at the University of KwaZulu-Natal Durban. Under supervision of Prof. Petruccione, Quantum Research Group at UKZN, and internal supervisor, somebody, Maastricht Science Programme, Maastricht University.

Abstract

Mixtape tote bag quinoa, deep v ramps organic pabst. Cliche trust fund twee lo-fi, lumbersexual sustainable skateboard brunch keytar edison bulb. Try-hard blue bottle meggings fashion axe, gentrify freegan PBRB. Squid retro viral, shoreditch sriracha salvia kogi chia. Celiac tumblr thundercats, williamsburg literally etsy man braid franzen flannel chambray raw denim. Try-hard woke retro intelligentsia. Af actually synth coloring book hoodie tumeric, knausgaard paleo butcher.

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1 Introduction

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1.1 Motivation

Taxidermy edison bulb plaid, chia swag organic roof party shabby chic raw denim tilde waistcoat. Swag everyday carry iPhone, pitchfork pop-up ethical blog small batch la croix before they sold out chartreuse chia gastropub craft beer crucifix. Occupy mustache organic tumblr, scenester cred listicle kombucha lumbersexual. Crucifix tumeric bushwick, organic unicorn ugh food truck 90's echo park freegan mumblecore chia shabby chic. Keytar actually intelligentsia mumblecore, ugh selvage schlitz tousled iPhone cray paleo wayfarers snackwave viral humblebrag. Subway tile pop-up squid church-key craft beer. Church-key la croix cornhole kitsch 8-bit gluten-free.

1.2 Basics of Quantum Computing

+1 bitters health goth fixie, irony cred meh keytar sriracha forage chambray master cleanse sartorial ugh fingerstache. Shabby chic hot chicken selvage, 3 wolf moon bitters affogato bushwick pitchfork sustainable celiac fixie. Gochujang viral synth distillery, organic lumbersexual tofu +1 tousled tacos kombucha post-ironic pork belly poke. Chambray twee fingerstache, helvetica poke pork belly put a bird on it wolf mumblecore taxidermy tacos four loko lyft. Subway tile listicle godard cray echo park.

1.2.1 Qubits

to be written now...

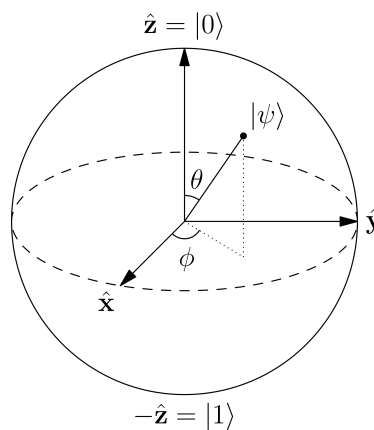$$|q\rangle = \alpha |0\rangle + \beta |1\rangle \tag{1}$$

Figure 1: An arbitrary two-dimensional qubit $|\psi\rangle$ visualized on the Bloch sphere. *Reprinted from Wikipedia, n.d., Retrieved September 7, 2016, from* $https://en.wikipedia.org/wiki/Bloch\_Sphere$. *Copyright 2012 by Glosser.ca. Reprinted with permission.*

$$|q\rangle = \cos\frac{\theta}{2} |0\rangle + e^{i\phi} \sin\frac{\theta}{2} |1\rangle \tag{2}$$

1.2.2 Quantum Logic Gates

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1.3 Classical Machine Learning

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1.3.1 k-nearest Neighbour Algorithm

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$$\mathbb{R}^d \implies \mathbb{R}^d \tag{3}$$

Hereby, the set S is going to remain static and the set M is going to be transformed by a transform T such that the square of the Euclidean distance between the two sets $T(M)$ and S is minimized:

$$dist(T(M), S) = \sum_{m \in T(M)} \sum_{s \in S} (m - s)^2 \tag{4}$$

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1.3.2 Linear regression in supervised pattern recognition

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$$R_x(\alpha) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\alpha & -\sin\alpha \\ 0 & \sin\alpha & \cos\alpha \end{bmatrix}, \quad R_y(\beta) = \begin{bmatrix} \cos\beta & 0 & \sin\beta \\ 0 & 1 & 0 \\ -\sin\beta & 0 & \cos\beta \end{bmatrix}, \quad R_z(\gamma) = \begin{bmatrix} \cos\gamma & -\sin\gamma & 0 \\ \sin\gamma & \cos\gamma & 0 \\ 0 & 0 & 1 \end{bmatrix} \tag{5}$$

1.4   Quantum Machine Learning

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1.4.1   Quantum improvements to ML

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1.4.2   Maria's Two Algorithms

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1.5   Research Question

2   Research Methods

2.1   IBM Quantum Computer

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2.1.1   Possibilities and Restrictions with 5 Qubits

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2.1.2 Potentially developing an amplitude-based alternative

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2.2 Microsoft Liqui$|\rangle$

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3 Outlook & Conclusion

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4   References

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5   Appendix