

Quantum vs Classical – survival of the fittest SVM

A venture into Support Vector Machines using Qiskit

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ABSTRACT

Support Vector Machines (SVMs) are an established classical machine learning method, where vectors are found through the problem space such that they divide up the problem data into separate classifications. Quantum computers are expected to be able to identify these vectors faster than classical hardware. Currently, quantum hardware is not at a point where the performance exceeds that of classical hardware. This poster presents results of an early experiment comparing the efficiency of algorithms ran on classical vs those ran on quantum hardware.

KEYWORDS

Quantum Computing, Qiskit, Machine Learning, SVM, Climate Change, Sustainability

INTRODUCTION

Since the 1940s algorithms have been developed for machine learning for classical computing devices [1]. However, when the problem space grows exponentially large, even the best classical hardware can begin to struggle. This is where quantum computers come in, as they are able to make use of an exponentially large state space and so can solve some machine learning problems more efficiently than classical computers [2].

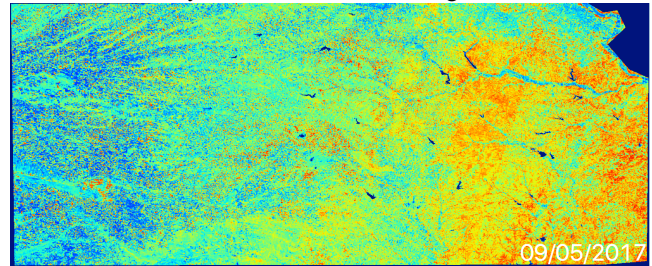
1 The Problem

Identifying which crops are grown in a region can be a problem for local authorities. This information can be used for many different things, for example to look at the impact of climate change (to see the change in land classified as woodland and the impact of deforestation) or to assess the impact of a new agricultural government policy [3]. These problems can be solved by looking at how normalized difference vegetation index (NDVI) changes over the year. NDVI readings are taken by a satellite and it is a measure of how much light is being reflected back off the earth, with higher values meaning more light is reflected. The NDVI readings for a certain moment in time are assembled into an image and each image becomes a feature in the dataset. As more and more images are included, the problem space quickly becomes large and so suited to being solved by a quantum computer. This comparison looked at working out which of the 3 main land uses (growing corn, growing soy or grassland) an area is being used for, in the state of Kansas.

2 The Solution

To solve this problem, a dataset was generated by taking the NDVI images of Kansas from approximately 9 months (roughly one

growing season) and then mapping them to a classification which was obtained from looking at a published planting map. The dataset ended up having 17 features – one feature per image used and was then filtered to only consist of the 3 uses being looked at.



An NDVI image for Kansas, May 2017. The redder the colour the more light is reflected.

This dataset was then fed into a quantum SVM algorithm provided by Qiskit Aqua[4] and also a classical SVM provided by sklearn so that the results of the classical method and the quantum method could be compared.

3 The Results

The algorithm was run locally on a quantum simulator provided by Qiskit Aer and on real quantum hardware, achieving results of around 80% accuracy. The classical algorithm achieved an accuracy of 83% on the same dataset.

4 The Conclusion

As the quantum hardware is not currently at the point where the performance of the quantum algorithm will supersede that of the classical algorithm, the quantum version is currently no better than the classical version. The reason the quantum algorithm is slightly worse than the classical algorithm is that it has to perform feature reduction so that it may be run on current hardware, as there are currently no devices with sufficient qubits to enable more than 3 features of the dataset to be used. In future, the quantum algorithm should match the classical algorithm on accuracy and have an improvement over it in the time it takes to perform the training.

REFERENCES

- [1] McCulloch, W.S. & Pitts, W. Bulletin of Mathematical Biophysics (1943) 5: 115. <https://doi.org/10.1007/BF02478259>
- [2] Havlíček, V., Córcoles, A.D., Temme, K., Harrow, A.W., Kandala, A., Chow, J.M. and Gambetta, J.M. 2019. Supervised learning with quantum-enhanced feature spaces. *Nature*. 567, 7747 (Mar. 2019), 209–212. DOI:<https://doi.org/10.1038/s41586-019-0980-2>
- [3] H. McNairn, J. Shang, C. Champagne and X. Jiao, "TerraSAR-X and RADARSAT-2 for crop classification and acreage estimation" 2009 IEEE International Geoscience and Remote Sensing Symposium, Cape Town, 2009
- [4] <https://qiskit.org/aqua>