Project Idea

Qiskit | Hackathon Europe

Quantstellar

We aim to demonstrate the quantum enhancement of QSVM for big data applications on a novel domain of astronomical object classification using the SDSS (Sloan Digital Sky Survey) dataset. We will benchmark our implementation against a classical SVM algorithm comparing time complexity and preciseness.

The research topic is highly relevant and a potential contribution to an actual project (Fink)

In the astronomy alert system, a lot of research has been conducted to prepare for one of the most ambitious astronomical projects, the so-called Legacy Survey of Space and Time (LSST), to be launched in 2022. LSST aims to chart the universe on a wider and deeper scale than all previous surveys combined. It is projected to capture more than 20 Terabytes of raw data and produce more than 10 million alerts every night.

Quantum enhancements are a solution to the big data challenges in astronomy and beyond

Astronomical alert systems often face a prominent challenge of exponential growth in data volume and algorithm complexity, making it harder to scale and implement complex classification algorithms. These challenges are not unique to astronomy but other fields such as genome sequency or high-frequency trading.

Our project aims to address the challenges of working with big data by leveraging quantum machine learning properties and optimizing QSVM for big data training and classification. We will validate our work using the high dimensional SDSS dataset and have many opportunities of development beyond the time period of the hackathon

Impact and Goals

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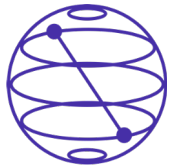
Short-term goals, minimum to be implemented within the hackathon timeframe

Big data solution

Show exponential quantum speedup in big data training and classification



Qiskit tutorial

Apply Qiskit's QSVM module to a novel real-life use case, with a ready to contribute Qiskit tutorial

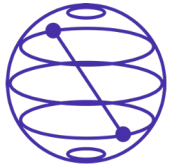
Webapp

Build a simple click-and-run webapp to apply trained model for new predictions

Long-term goals and opportunity for huge impact

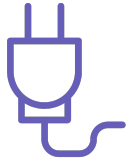
LSST 2022

Goal of enabling quantum implementation in the analysis of the LSST 2022 run



Qiskit

Extend Qiskit's QML capability by adding improved functionality for big data training and classification



Quantum plug-in

Extend prototype as a quantum plug-in for current alert system pipelines

Big data beyond astronomy

Big data algorithms can be applied to other projects both within and beyond the field of astronomy

Implementation Plan

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Descriptive Analytics

Load and understand the SDSS dataset

Skillset - data analysis
Key Team - Rossy, Sathvik
Resources – Kaggle, GitHub repo

Quantum ML

Encode data into quantum space, design quantum feature maps and train QSVM model on SDSS dataset

Skillset – Python, Qiskit, QML
Key Team – Calum, Sathvik, Zarreen
Resources – Qiskit AER and ML (Aqua), Research paper on QSVM, ML in Astronomy

Benchmark

Performance testing using classical SVM as a benchmark.

Skillset – Python, Qiskit, QML
Key Team – Calum, Zarreen, Rita
Resources – SVM repository

Prototype

Demo prototype on webapp

Skillset – Python, Streamlit
Key Team – Rossy, Rita
Resources – Streamlit

Develop

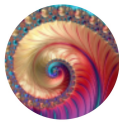
Finalise code for Qiskit Tutorial and develop project beyond SDSS example

- Improve general big data functionality for Qiskit

The team

Rossy Ng
Software development
Games

Calum Holker
QML
Data Science



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QML

Resources

- Qiskit QSVM Library -https://qiskit.org/documentation
- QSVM for big data - https://arxiv.org/pdf/1307.0471.pdf
- ML in Astronomy - https://arxiv.org/pdf/1904.07248.pdf
- SDSS Dataset - https://www.sdss.org
- Supervised learning with quantum enhanced feature spaces - https://arxiv.org/pdf/1804.11326.pdf
- Streamlit -https://streamlit.io