Quantum Machine Learning for Earth Observation

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European Funds Smart Growth
Republic of Poland
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European Union European Regional Development Fund
CAMK PAN

Project and Grants

1. Projects
   - Monte Carlo simulation for Pulse Shape Discrimination
   - Quantum Machine Learning with Multispectral Data
   - Semantic segmentation using Quantum Machine Learning

2. Grants
   - Ongoing - ESA OSIP Grant

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Section 1

Projects

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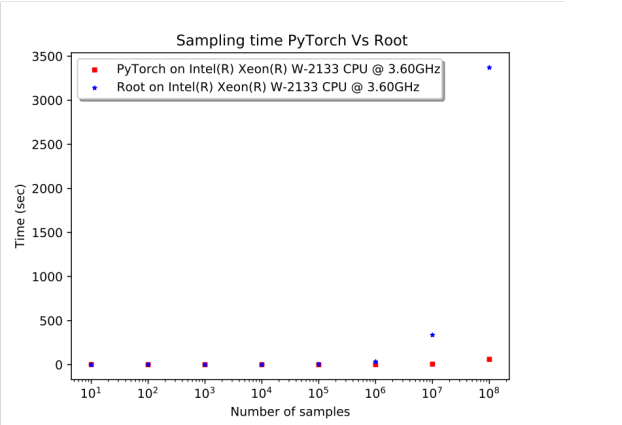
Pulse Shape Discrimination (PSD) using PyTorch

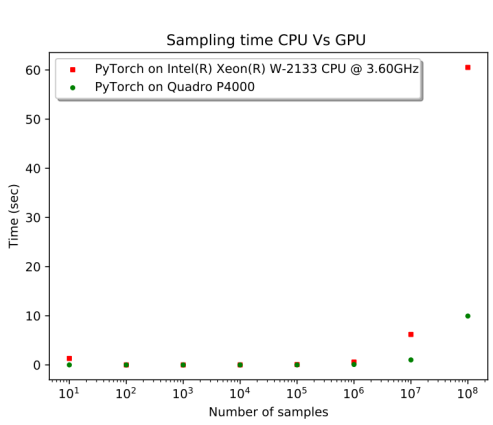
To Develope distributed Monte Carlo based estimation for DEAP-1 argon detector scintillation pulse shape in PyTorch. The analytic PSD model is from the DEAP-1 paper, arxiv:0904.2930.

Results

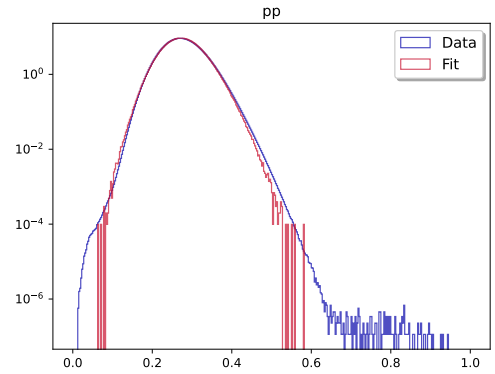
Pytorch based MC is 360 times faster on GPU than the ROOT implementation on CPU for 10^8 samples. The PSD model was improved by using emperical Photo Detection Probability.



(a)



(b)



(c)

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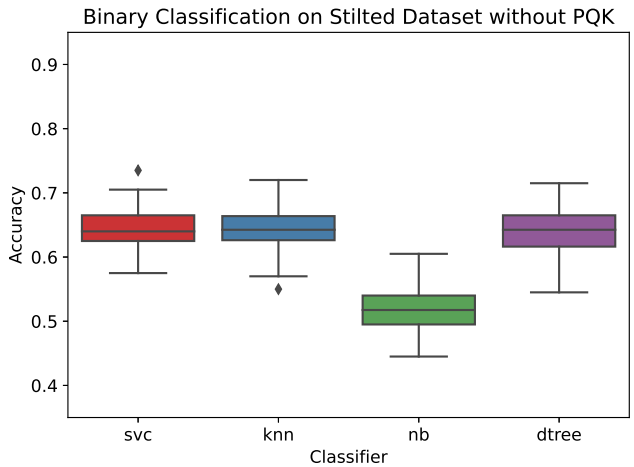
Quantum Machine Learning with Multispectral Data

Objective

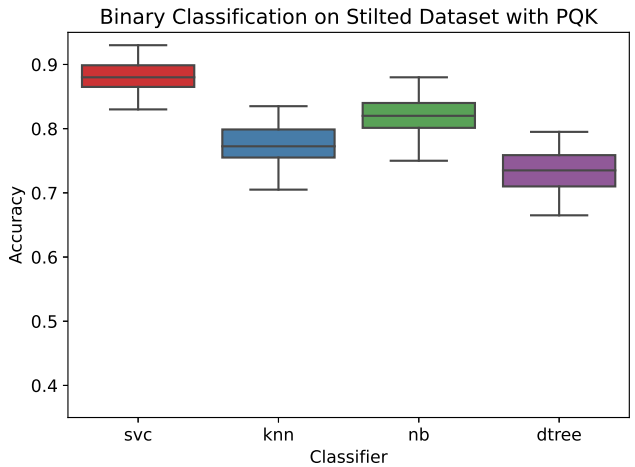
To analyse if quantum machine learning is suitable for processing Multispectral Earth observation data.

Resullt

1. We show that there exists a dataset where quantum ML model outperforms the classical ML model in test accuracy.



(d)



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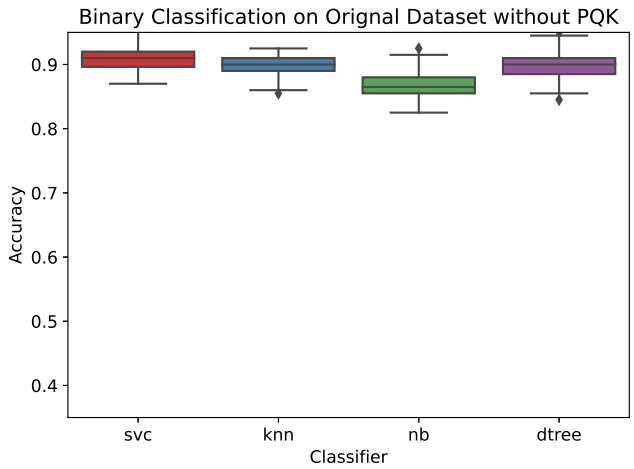
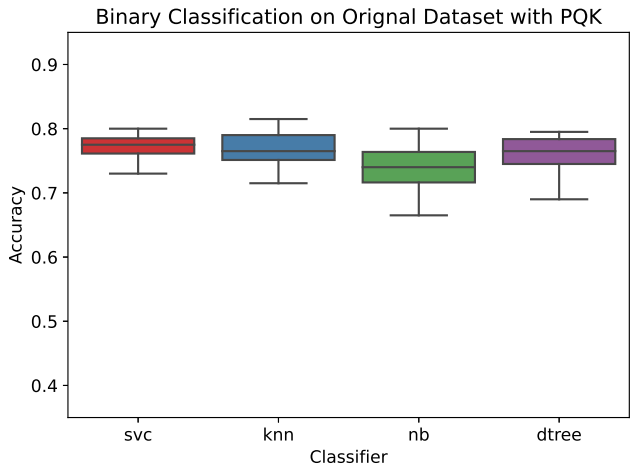


(f)



(g)

Publication

"Potential of Quantum Machine Learning for Processing Multispectral Earth Observation Data , **Manish K. Gupta**, Michał Romaszewski, and Piotr Gawron" is available on preprint (https://www.techrxiv.org/doi/full/10.36227/techrxiv.21898902.v1).

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Semantic segmentation using Quantum Machine Learning

Objective

Change detection consists of identifying change in pre-defined areas of interest in a multispectral image by comparing a pair of images that has been observed over a period of time by earth observation mission e.g. urban changes. We prpose to use quantum machine learning for Change detection.

(h)

(i)

(j)

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Result

1. The pixel wise binary classification gives a balanced accuracy of $\sim 76\%$ with less than 50 parameters.
2. The patch wise classification is in progress.

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Section 2

Grants

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Ongoing - ESA Open Space Innovation Platform (OSIP) Grant

The goal of this proposal is to build a Quantum Machine Learning system for land cover classification of the Earth surface based on Sentinel-2 images. (PI: Piotr Gawron)

Figure: Spectral information processing with quantum neural networks.

Thank you for your attention!

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