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Covalent x IBM: MRI Image Classification Using Quantum Convolutional Neural Networks

iQuHack 2023 : Group 17



Problem

- The objective of this project is to create a quantum-powered, user-friendly application capable of medical image classification.
- The vision of this project is to provide a flexible application, such that patients could augment medical treatment with immediate, real-time AI consultation.
- We accomplished this by implementing a quantum convolutional neural network (QCNN) in order to classify MRI images.
- Following <https://doi.org/10.48550/arXiv.2109.02862>, we trained the QCNN on 2D grayscale images of the brains of Alzheimer's patients exhibiting mild, moderate, and no signs of dementia.
- We paired this classification method with user-interface that could be used by patients to view the categorization of their individual MRI scans.

The Algorithm

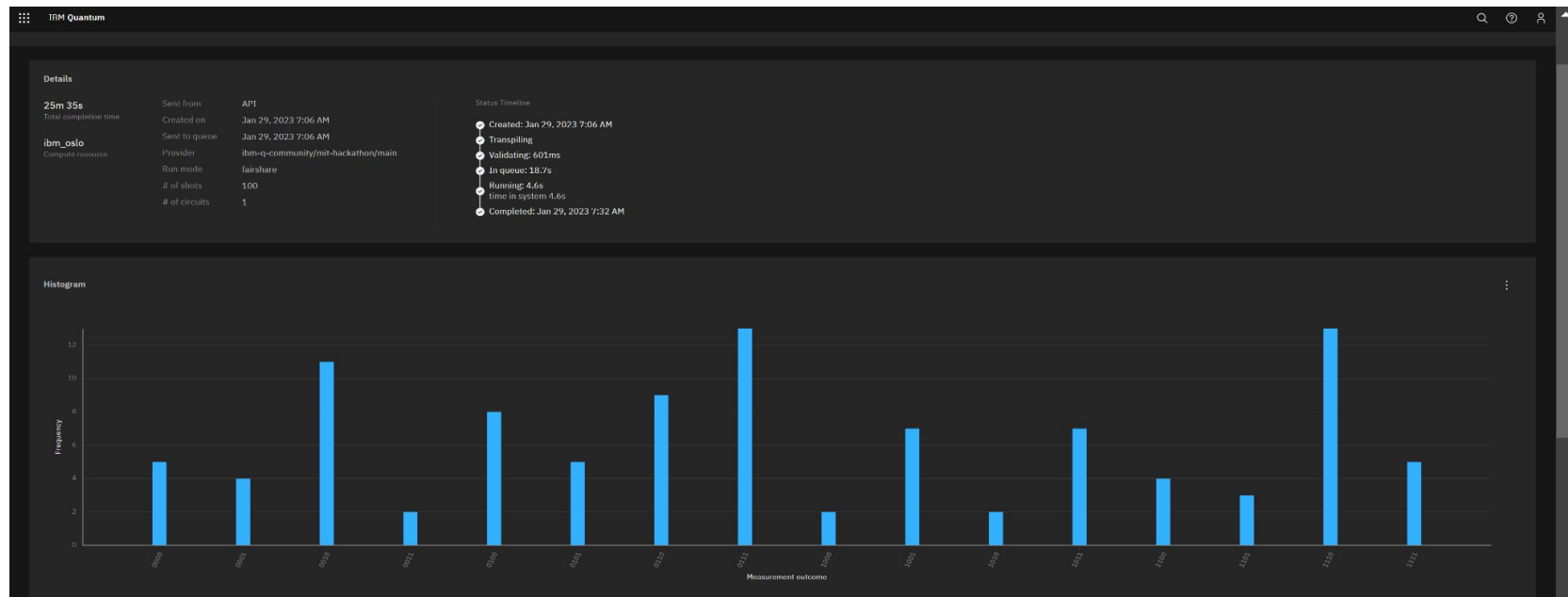
- We implement a Quconvolutional Neural Network, used as a filter which allows to encode image segments as input state of a quantum circuit
- The grayscale images had to be manually labeled and converted to a series of vectors. All images were categorized into one of three categories: mild, moderate, and no signs of dementia.
- After this image processing, we train the Quantum NN
- QNN allows for faster processing times which allow for higher resolution images and removes the need for max pooling, necessary for dimensional reduction.
- The NN outputs binary vectors which corresponds to measuring the detected classes.

Results

```
!python run.py

... ./quanv_datasets/Training.csv
Time per batch (0): 1297.9432957172394
[[0 7 0]
 [0 4 0]
 [0 4 0]]
Epoch: 0 TR_Loss: 1.1969388723373413, TR_Acc: 0.26666666666666666
[[3 0 0]
 [6 0 0]
 [5 0 1]]
Epoch: 0 VAL_Loss: 460.81536865234375, VAL_Acc: 0.26666666666666666
Time for Epoch (0): 2592.4003343582153
Time per batch (0): 1287.4307355880737
[[7 0 0]
 [4 0 0]
 [3 0 1]]
Epoch: 1 TR_Loss: 291.1871032714844, TR_Acc: 0.5333333333333333
```

Results cont.



App architecture

