Project: QML class spring 2024. Total credit 10.

Due to 15 June 2024

6/10 credits

Simulate in python a quantum classifier using a variational quantum circuit for classifying data for the binary classification parity problem with 3 inputs. I provide you both train and test data which have been produced by adding some noise around the edges of a cube, see Figure 1. You are allowed to shift the data or else to make some simple preprocessing of the data, for instance subtract 0.5 from all data.

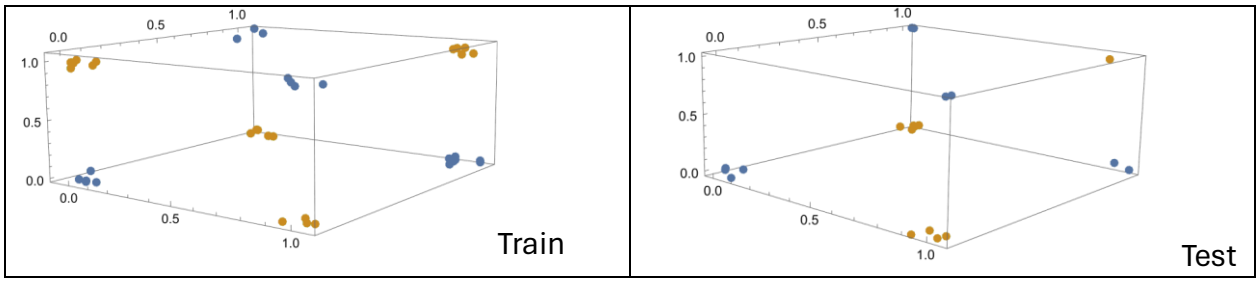

Figure 1. Plots of the train and test data (classA_train.dat, classB_train.dat, classA_test.dat, classB_test.dat files).

You should provide:

a) the design of the circuit you have built including measurements. My advice is not to exceed 4 qubits circuit.

b) the cost function you have selected build by the expectation value of measurements at the end of the circuit

c) your selected optimization method

d) the outcomes of classification (e.g. accuracy) on train and test data

e) your program

2/10 credits

Use your model and make some research on one of the following issues:

- Compare different classical optimization methods and/or loss functions
- Justify your model by presenting geometric representations using Bloch sphre
- Compare the number of parameters, epochs, structure with a classical NN that solves the same problem
- Involve parameter-shift rule for the evaluation of gradients
- Use your classifier to solve another binary classification problem with 3 inputs and report the outcomes.
- Any other subject that you find interesting

For all these you can ask for bibliography and discuss with me if needed!

2/10 credits

Extend your model to classify data from the parity problem with 5 inputs. Relevant files: classA_train_N5.dat, classB_train_N5.dat, classA_test_N5.dat, classB_test_N5.dat