Getting started with QML

1 Motivation

Machine learning is the discipline of producing mathematical functions that replicate patterns from large amounts of data. The requirements for these kinds of algorithms are enormous computing power and the ability to work with many data points. This requirement of scale means that machine learning techniques, even though they have been known for decades, have not been used in real world situations until very recently. How can quantum solve this? Many machine learning techniques rely on more basic tasks such as linear system solving for their functioning. These linear equations can be efficiently solved using the HHL algorithm, named after its inventors Harrow, Hassidim and Lloyd.

Quantum machine learning is an emerging field that combines the principles of quantum mechanics and machine learning to develop new algorithms and techniques for solving complex computational problems. The central obstacle to this approach is the data input problem: it is not yet known how to input the large noisy datasets used in machine learning into a quantum computer.

2 Walkthrough

- Basics of Quantum Computing including quantum states, quantum gates, quantum entanglement
- Quantum Algorithms: Review some of the basic quantum algorithms, such as the quantum Fourier transform and the quantum phase estimation algorithm, and understand how they can be used in machine learning. Quantum machine learning relies on the use of quantum algorithms to perform tasks such as classification, clustering, and optimization.

- Classical machine learning: Quantum machine learning builds on the foundations of classical machine learning, so it is important to have a basic understanding of classical machine learning algorithms and techniques, such as supervised and unsupervised learning, decision trees, and neural networks

- Explore quantum machine learning algorithms: There are several quantum machine learning algorithms that have been developed in recent years, including quantum support vector machines, quantum neural networks, quantum principal component analysis and quantum linear regression. It may be helpful to study these algorithms in more detail to get a sense of the types of problems they can be used to solve.

- Explore QML libraries and frameworks: Qiskit, PennyLane(Xanadu), TensorFlow Quantum

- Research and applications in quantum machine learning: There are many active research areas in quantum machine learning, including quantum neural networks, quantum kernel methods, and quantum feature maps. You may want to read about current research in these areas to get a sense of the types of problems.