QUANTUM MACHINE LEARNING

QUANTUM MACHINE LEARNING PREPARATORY

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# LEARNING OBJECTIVE

This is NOT a tutorial to learn Quantum Machine Learning but a preparatory tutorial to build the prerequisite to learn QML. It is written for anyone who is interested in pursuing applications of Quantum Computing in Machine Learning assuming the reader has no prior knowledge on Quantum Mechanics or Computation.

Learning Quantum Computation is hard, definitely requires change of mindset and paradigm shift. In classical probability theory, the value of probability is restricted to 0 to 1. It must not be negative. However, in the Quantum world, probability can be negative. In a coin tossing experiment, the outcome is either Head or Tail. In it’s counterpart in Quantum, the outcomes are Head and Tail and anything in between. These outcomes are called Quantum States. Loosely, states in between Head and Tail are 10% H 90% T, 40% H 60% T and so forth. H and T appearing at the same time is called Superposition.

How many states exist in between H and T? The answer depends on the number of Qubits that we use. A Qubit is the basic unit in Quantum Information. In classical computer, the basic unit of information is a bit. 1 byte of information is made of 8 bits of 0s and 1s. In Quantum Information, N number of qubits give us *2N* states. For example, 2 qubits give us 4 states, 4 qubits give us 16 states, and so on.

# HOW THIS TUTORIAL IS STRUCTURED

By rule of thumb, reader should adopt the following sequence:

1. Review classical probability. Although quantum information is weird as described above, there are similarities.
2. Quantum States.
3. Quantum Computation.

This tutorial has an accompanying Jupyter Notebook Quantum\_ML\_Prep.ipynb. The important concepts and techniques will be explained in text as well as in codes in the Jupyter..

LESSON 1: CLASSICAL PROBABILITY VS QUANTUM