What is Quantum Computation?

The development of Quantum Mechanics over the last century has paved the way for the new paradigm of computation. Paul Benioff with his research on Quantum Information and Quantum mechanical model of Turing Machines pioneered the field of Quantum Computing. Quantum computation is based on the postulates of quantum mechanics which define the way quantum systems behave. In the last couple of decades, many theoretical quantum algorithms have been developed which suggest a possible superiority of quantum computers over their classical counterparts. This section discusses, in brief, the basics of quantum computing required to build more complex algorithms which can help to solve some of the challenging problems faced by classical computers.

The most basic unit of computation for classical computers is a *bit (binary digit)* which is used to store and process information. Quantum computers make use of a similar unit of information called *Qubit.* Unlike the bit which can represent either a zero state or one state at any given time, Qubits can simultaneously be in a superposition state of both |0> and |1> state. More precisely, the state of a single qubit is a unit vector in a 2-dimensional complex vector space called *Hilbert Space*. |0> and |1> states of the qubit vector are called the orthonormal basis of the given Hilbert space. Fig shows the Bloch sphere representation of the qubit state vector.

Why Quantum Computation is required?

Qubit

Single and Multi-Qubit Gates

Circuit

Entanglement, Superposition, Quantum Parallelism

Quantum Machine Learning

Quantum Classifiers