Quantum Gates

In quantum computing and specifically the quantum circuit model of computation, a quantum logic gate (or simply quantum gate) is a basic quantum circuit operating on a small number of qubits. They are the building blocks of quantum circuits, like classical logic gates are for conventional digital circuits.

Unlike many classical logic gates, quantum logic gates are reversible. It is possible to perform classical computing using only reversible gates. For example, the reversible Toffoli gate can implement all Boolean functions, often at the cost of having to use ancilla bits. The Toffoli gate has a direct quantum equivalent, showing that quantum circuits can perform all operations performed by classical circuits.

Hadamard Gate

The Hadamard Gate is a well-known gate in quantum computing that achieves this. Similar to the Pauli-X gate, the Hadamard Gate acts on a single qubit, and can be represented by a 2 x 2 matrix as well.

The Hadamard Gate is defined as follows:

$$\sqrt{2} \quad 1 \quad -1)$$

We want to find out what happens when we apply this gate on a qubit that is in the |0> state. This can be inspected by multiplying the gate matrix to the qubit vector.

CNOT Gate

CNOT is a quantum logic gate that is an essential component in the construction of a gate-based quantum computer. It can be used to entangle and disentangle Bell states.

SWAP Gate

The SWAP gate performs half-way of a two-qubit swap. It is universal such that any many-qubit gate can be constructed from only SWAP and single qubit gates. The SWAP gate is not, however maximally entangling; more than one application of it is required to produce a Bell state from product states.