**ACM VIT Research Writeup – Quantum Computing**

Grover's algorithm is a search algorithm performed by quantum computers that has effectively O(root n) complexity. Comparatively speaking, for a normal computer searching algorithms are limited to binary and linear search, whose complexity is O(log n) for sorted input and O(n) for unsorted input respectively. Additional searching algorithms have minor optimizations which improve complexity under certain conditions but average performance tends to lie near these bounds as well. Hence, for unsorted input it is effectively a quadratic speedup process.

Addressing the additional searching algorithms, Grover’s algorithm does not solve a specific problem class better than a custom classical algorithm, but offers a universal solution for all search problems. Quantum computers effectively change the conception of bits and data processing, we are able to apply these concepts to explore solutions beyond the scope of classical machinery.

In Grover's algorithm, we notice use of the following functions: oracle, diffusion operator, main circuit and the simulator. Each function serves unique function and purpose in functioning of the code. Oracle function acts as the key, it sets the state to be searched for in the algorithm using a CZ gate which is a 2-qubit quantum gate where one bit is the control and determines whether operations (here Z gate - phase shift applied to 1> component) applied to the other qubit. The diffusion operator amplifies the correct answer, flipping the values around the average, then applying Hadamard gate to get all states in equal amplitude, move from amplitude to phase basis and use not gate to invert 0> state and then undo the effects by applying all gates again. Grover circuit is then used to create circuit with qubits used to explore possibilities and classical bits for final output, mark the answer again using the oracle, amplify the value and convert quantum states to classical bits. Then we use, Aer simulator which creates a quantum simulator that is a virtual quantum computer running to get final measurement of each classical bits, summation of which determines number of cycles and for the bits shows the frequency of occurrence, finding the value marked by the oracle.

Learning about the quantum computers through the tasks has been an exciting and curiosity driven journey, I intend to continue learning and contributing through the chapter.