Experiment No – 5

Aim: Implement Tarrataca's quantum production system with the 3-puzzle problem

Outcome: At end of this experiment, student will be able to Write a Python Program using Tarrataca's quantum production system with the 3-puzzle problem.

Software Requirement: Quiskit

Theory:

Tarrataca's quantum production system is a quantum algorithm for solving combinatorial optimization problems. It works by constructing a quantum circuit that represents the problem space, and then applying a sequence of quantum operations to the circuit to search for the optimal solution.

The 3-puzzle problem is a combinatorial optimization problem where the goal is to arrange three tiles in order, given an initial state. Each tile can be moved either left or right, and the cost of a move is equal to the distance that the tile is moved.

To implement Tarrataca's quantum production system for the 3-puzzle problem, we can use the following steps:

Encode the problem state as a quantum state. We can use a qubit to represent each tile, and the state of the qubit will represent the position of the tile. For example, if a tile is in the leftmost position, we can represent it with the qubit state $|0\rangle$, and if it is in the rightmost position, we can represent it with the qubit state $|1\rangle$.

Construct a quantum circuit that represents the problem space. The quantum circuit will have a qubit for each tile, and the gates will represent the possible moves that can be made. For example, we can use a CNOT gate to represent a move that exchanges the positions of two tiles.

Apply a sequence of quantum operations to the circuit to search for the optimal solution. We can use a variety of quantum algorithms to search for the optimal solution, such as Grover's algorithm or amplitude amplification.

Measure the qubits to obtain the optimal solution. Once we have found the optimal solution, we can measure the qubits to obtain the positions of the tiles.

Here is an example of a quantum circuit that can be used to solve the 3-puzzle problem:

q0: ---

q1: ---

q2: ---

CNOT q0 q1

CNOT q1 q2

H q0

H q1

H q2

Grover's algorithm

M q0

M q1

M q2

This circuit starts with the three qubits in the state $|000\rangle$. The first two CNOT gates exchange the positions of the first two qubits and the second two qubits, respectively. The three Hadamard gates put the qubits into a superposition of states.

Grover's algorithm is then used to search for the optimal solution. Grover's algorithm is a quantum algorithm that can amplify the probability of finding a solution to a search problem.

Finally, the three qubits are measured to obtain the optimal solution.

Tarrataca's quantum production system is a powerful algorithm for solving combinatorial optimization problems. It has the potential to solve problems that are intractable for classical computers.