N-QUEENS PROBLEM

Name – AYUSH SAROJ

Branch – CSE (AI & ML)

Section – A

University Roll No. – 202401100400068

Subject – Introduction To AI

Subject Code – AI101B

Assignment Submitted To – Mr. BIKKI GUPTA SIR

INTRODUCTION

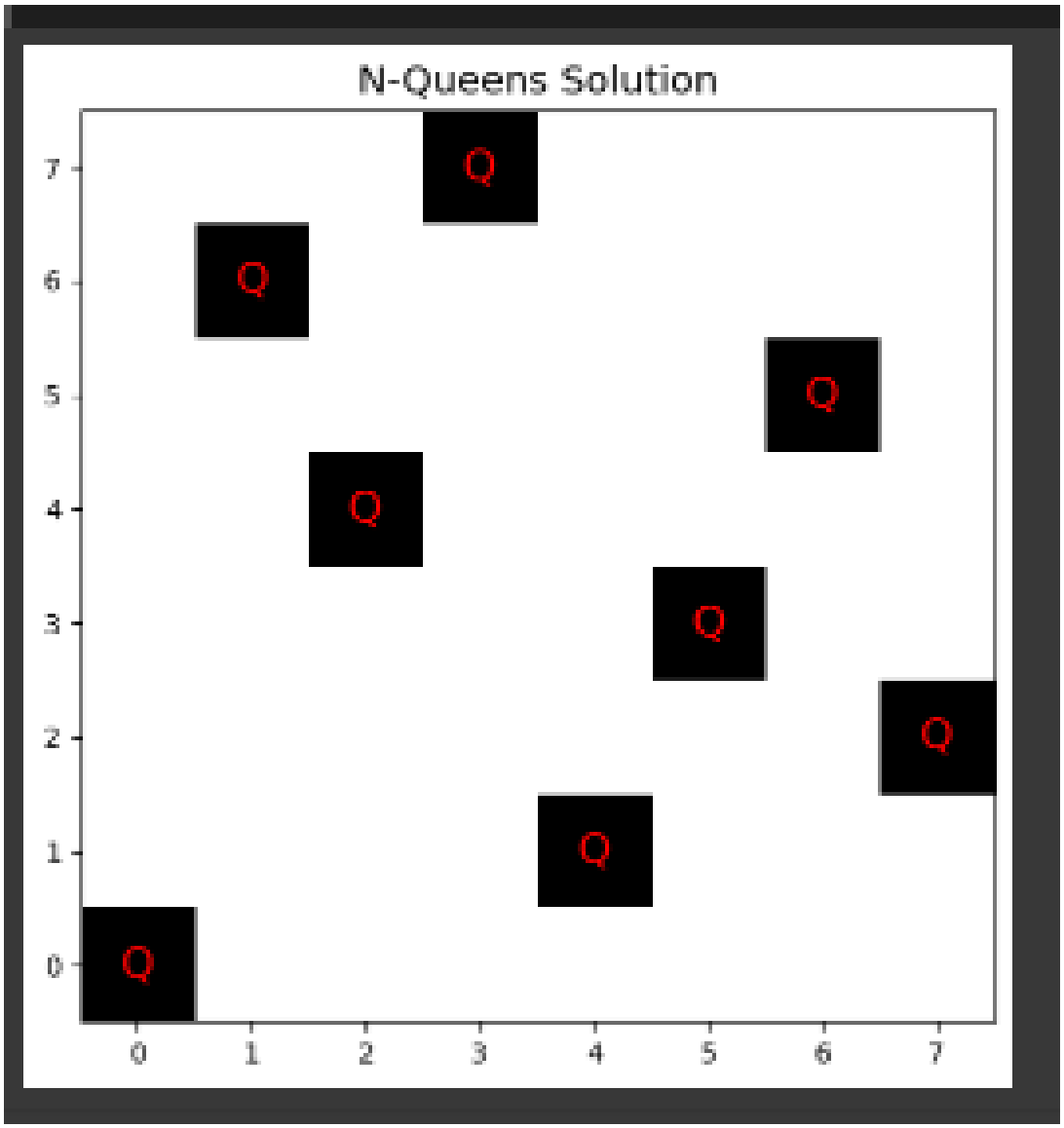
The N-Queens problem is a classic problem in Mathematics and Computer Science. It involves placing N chess queens on an N x N chessboard such that no two queens threaten each other. In other words:

1) No two queens can be in the same row.
2) No two queens can be in the same column.
3) No two queens can be on the same diagonal.

The final goal is to find all valid arrangements or a single valid arrangement of queens on the board.

METHODOLOGY

The Hill Climbing method is a search technique applied to optimization problems. It is based on the hill-climbing metaphor, where the aim is to ascend to the top of the hill (optimal solution) by iteratively refining a candidate solution. The algorithm begins with a starting solution and gradually advances towards improved solutions by examining neighbouring states.



VISUALISED N-QUEENS BOARD

CODE

```
import random #imports random library
import pandas as pd
import matplotlib.pyplot as plt
# this function is defined to find the number of conflicts for a given configuration
def calculate_conflicts(board):
    conflicts = 0
    n = len(board)

    for i in range(n):
        for j in range(i + 1, n):
            if board[i] == board[j] or abs(board[i] - board[j]) == j - i:
                conflicts += 1
    return conflicts
# this function is to generate a random configuration of queens
def random_queen_configuration(n):
    return [random.randint(0, n - 1) for _ in range(n)]
```

```
# this function is defined to perform hill climbing search for the N-Queens solution
def hill_climbing(n):
    board = random_queen_configuration(n)
    conflicts = calculate_conflicts(board)

    if conflicts == 0:
        return board

    while True:
        best_board = None
        best_conflicts = conflicts

        for row in range(n):
            for col in range(n):
                if col == board[row]:
                    continue

                new_board = board[:]
                new_board[row] = col
                new_conflicts = calculate_conflicts(new_board)
```

```
                if new_conflicts < best_conflicts:
                    best_conflicts = new_conflicts
                    best_board = new_board

        if best_conflicts == conflicts:
            break

        board = best_board
        conflicts = best_conflicts

        if conflicts == 0:
            return board

    return board
#displaying the board in a human-readable way
def display_board(board):
    n = len(board)
    for i in range(n):
        row = ['Q' if j == board[i] else '.' for j in range(n)]
        print(' '.join(row))
```

```
# to test the solution for different values of N
def solve_n_queens(n):
    solution = hill_climbing(n)
    display_board(solution)
    print("\nSolution found!")
# Function to generate the chessboard as a Pandas DataFrame
def create_chessboard(board):
    """
    Create a DataFrame representation of the chessboard.
    Rows and columns with queens will be marked as 1, others as 0.
    """
    n = len(board)
    chessboard = [[0] * n for _ in range(n)]

    for i, col in enumerate(board):
        chessboard[i][col] = 1  # Mark the queen's position as 1

    df = pd.DataFrame(chessboard)
    return df
```

```
# Function to visualize the N-Queens board
def visualize_n_queens(board):
    """
    Visualize the N-Queens board using Matplotlib.
    """
    df = create_chessboard(board)
    plt.figure(figsize=(6, 6))
    plt.imshow(df, cmap="Greys", interpolation="nearest")

    # Add the queens as red markers
    for i, col in enumerate(board):
        plt.text(col, i, "Q", ha="center", va="center", color="red", fontsize=16)

    plt.title("N-Queens Solution", fontsize=14)
    plt.xticks(range(len(board)))  # Show column indices
    plt.yticks(range(len(board)))  # Show row indices
```

```
    plt.gca().invert_yaxis()  # Invert y-axis to match chessboard convention
    plt.show()

# Example N-Queens solution
if __name__ == "__main__":
    # Example board configuration for N = 8
    solution = [0, 4, 7, 5, 2, 6, 1, 3]  # A valid solution for the 8-Queens problem
    visualize_n_queens(solution)

# Example usage
if __name__ == "__main__":
    try:
      while True:
        n=int(input("Enter Value of N = "))
        print("\nSolution for N = ",n,":\n")
        solve_n_queens(n)
    except:
      print("Error !")
```

Output :

```
Enter Value of N = 3

Solution for N =  3 :

Q - -
- - Q
Q - -

Solution found!
Enter Value of N = 7

Solution for N =  7 :

- - - - - Q -
- Q - - - - -
- - - - Q - -
Q - - - - - -
- - - Q - - -
- - - - - - Q
- - Q - - - -

Solution found!
Enter Value of N = 8

Solution for N =  8 :

- - - - - Q - -
- - Q - - - - -
Q - - - - - - -
- - - - - - - Q
- - - - Q - - -
- - - - - - - Q
- Q - - - - - -
- - - - - - Q -

Solution found!
Enter Value of N = 10

Solution for N =  10 :

- - - - - - - - Q -
- - - - Q - - - - -
Q - - - - - - - - -
- - - - - - - - - Q
- - - - - - Q - - -
- Q - - - - - - - -
- - - Q - - - - - -
- - - - - - - Q - -
- - - - - - - - - Q
- - Q - - - - - - -

Solution found!
Enter Value of N = x
Error !
```

REFERENCES

- https://www.naukri.com/code360/library/n-queen-problem?form=MG0AV3
- https://leetcode.com/problems/n-queens/description/?form=MG0AV3
- https://algo.monster/liteproblems/51?form=MG0AV3
- https://docs.python.org/3/