Name: Rishi Tiku

Class: SE DS

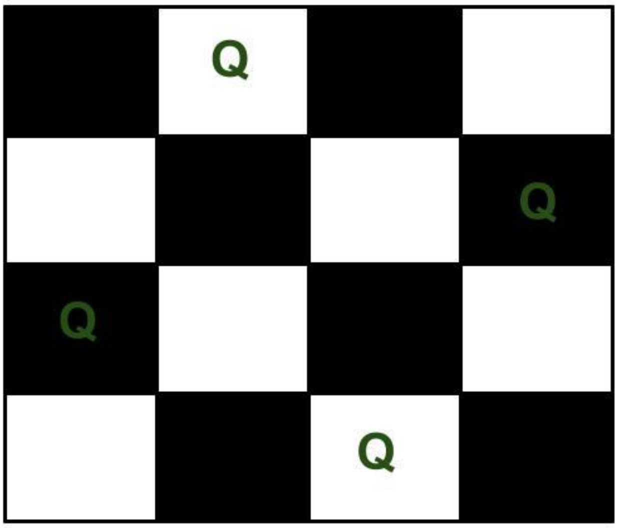
UID: 2021700067

Subject: DAA LAB

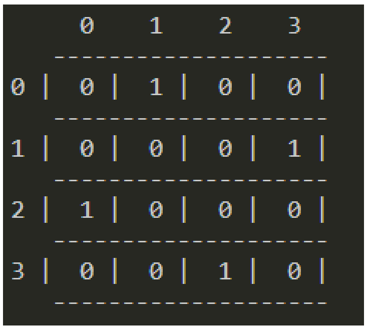
Experiment: 8

Aim: To implement backtracking to solve N-Queens problem

Problem: The N Queen is the problem of placing N chess queens on an N×N chessboard so that no two queens attack each other. For example, the following is a solution for the 4 Queen problem.



The expected output is in form of a matrix that has 1s for the blocks where queens are placed and the empty spaces are represented by 0s.

For example: 

```
     0    1    2    3
   -------------------
0 |  0 |  1 |  0 |  0 |
   -------------------
1 |  0 |  0 |  0 |  1 |
   -------------------
2 |  1 |  0 |  0 |  0 |
   -------------------
3 |  0 |  0 |  1 |  0 |
   -------------------
```

Algorithm for N queen problem:-

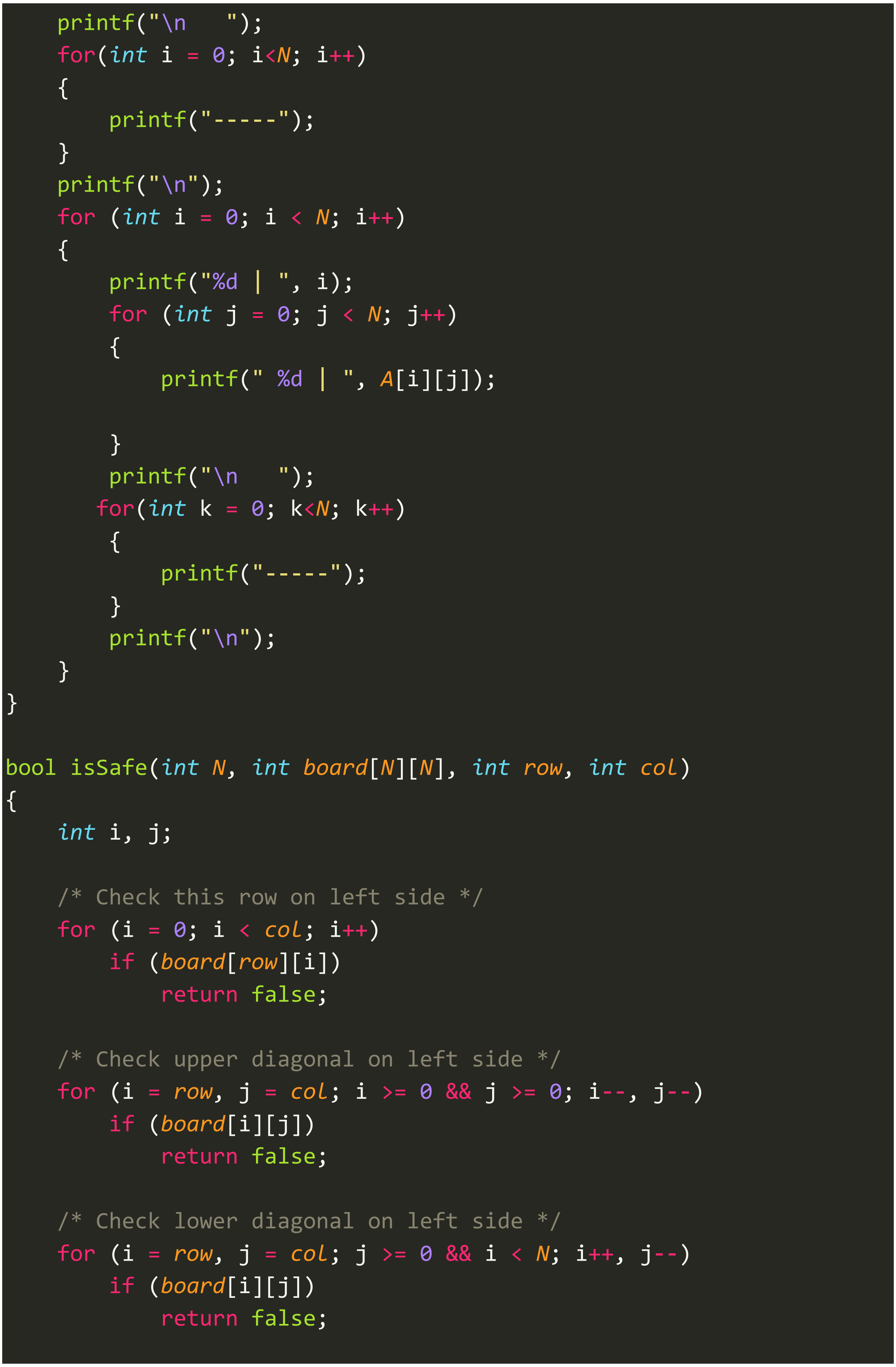
- Initialize an empty chessboard of size NxN.
- Start with the leftmost column and place a queen in the first row of that column.
- Move to the next column and place a queen in the first row of that column.
- Repeat step 3 until either all N queens have been placed or it is impossible to place a queen in the current column without violating the rules of the problem.
- If all N queens have been placed, print the solution.
- If it is not possible to place a queen in the current column without violating the rules of the problem, backtrack to the previous column.
- Remove the queen from the previous column and move it down one row.
- Repeat steps 4-7 until all possible configurations have been tried.

Pseudo-code implementation:

```
function solveNQueens(board, col, n):
  if col >= n:
    print board
    return true
  for row from 0 to n-1:
    if isSafe(board, row, col, n):
      board[row][col] = 1
      if solveNQueens(board, col+1, n):
        return true
      board[row][col] = 0
  return false

function isSafe(board, row, col, n):
  for i from 0 to col-1:
    if board[row][i] == 1:
      return false
  for i,j from row-1, col-1 to 0, 0 by -1:
    if board[i][j] == 1:
      return false
  for i,j from row+1, col-1 to n-1, 0 by 1, -1:
    if board[i][j] == 1:
      return false
  return true

board = empty NxN chessboard
solveNQueens(board, 0, N)
```

Code

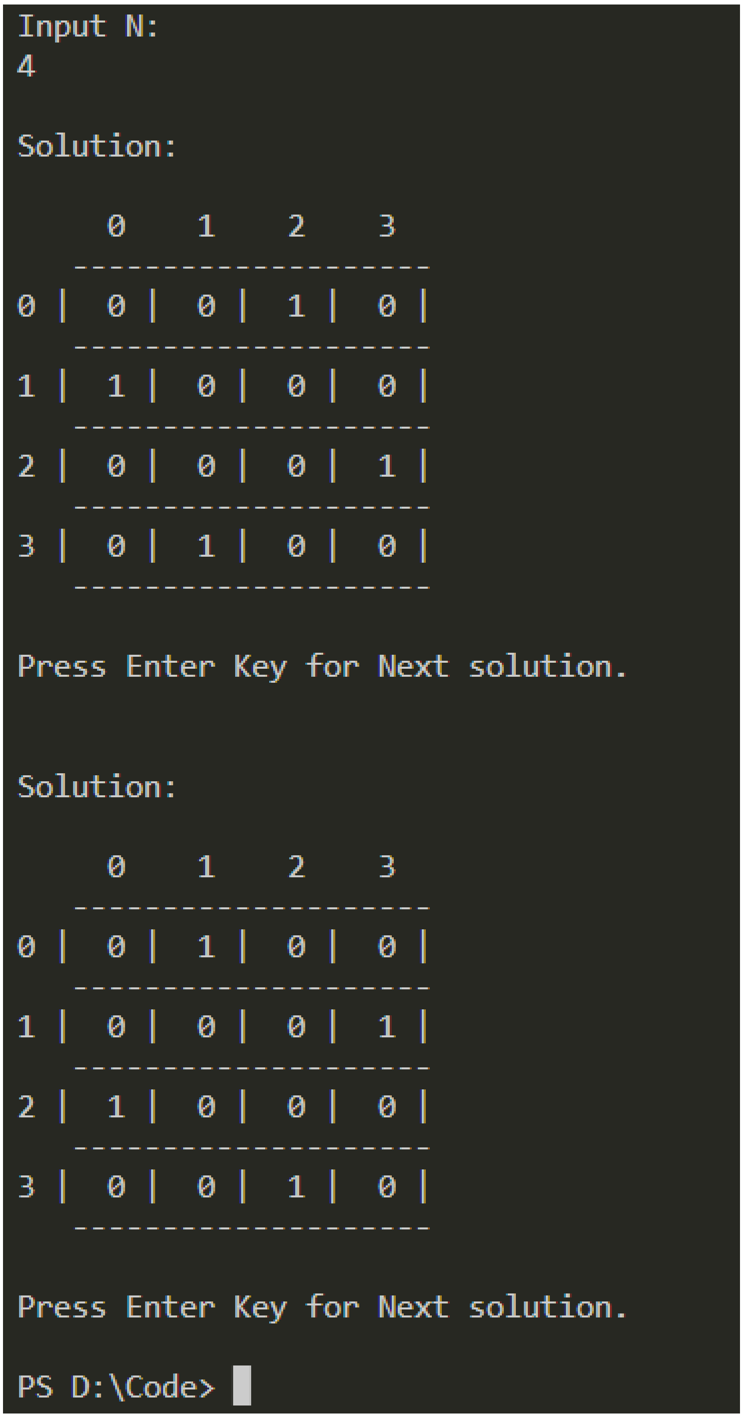
```c
#include <stdbool.h>
#include <stdio.h>
#include <stdlib.h>

void Display(int N, int A[N][N])
{
    printf("\n     ");
    for(int i = 0; i<N; i++)
    {
        printf("%d    ", i);
    }
```



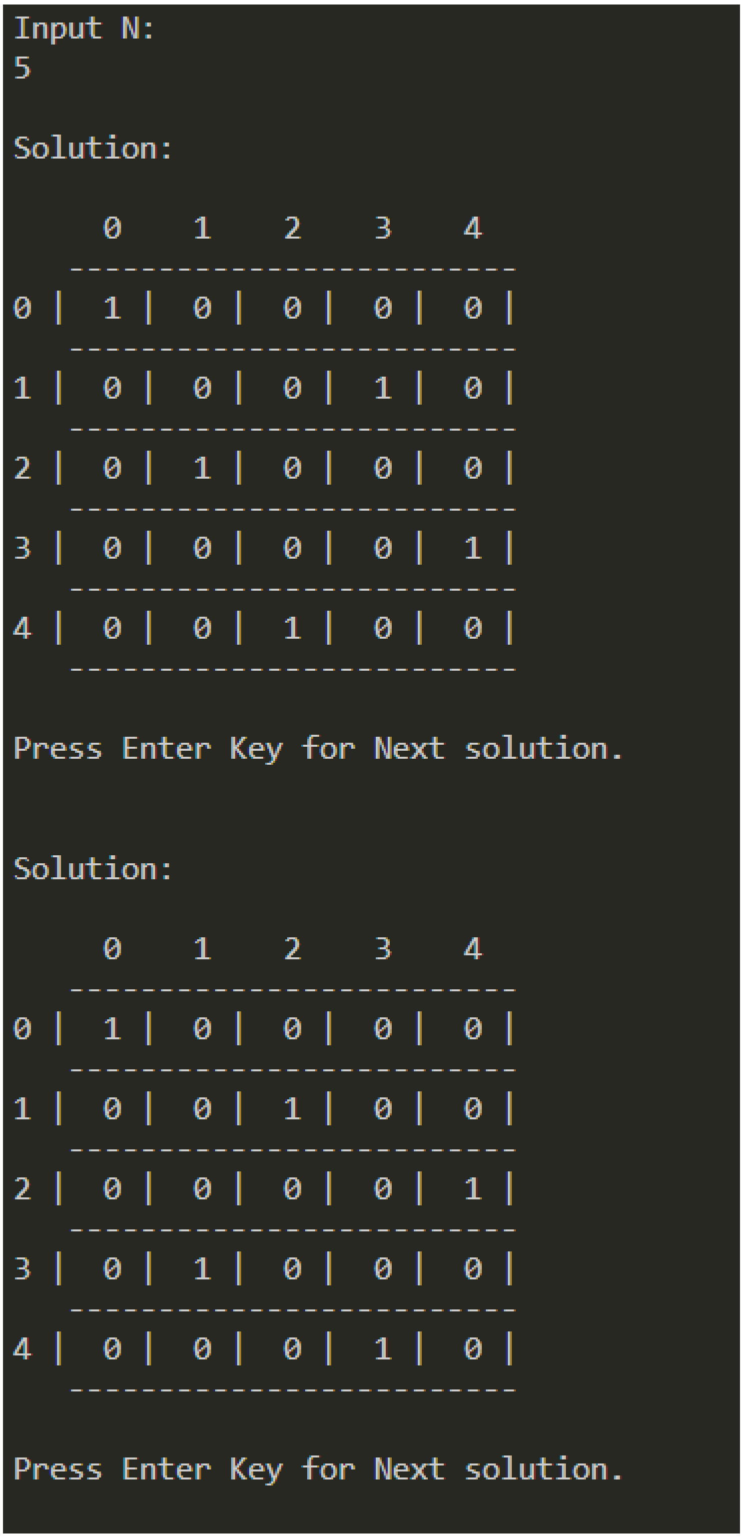
```c
    printf("\n   ");
    for(int i = 0; i<N; i++)
    {
        printf("-----");
    }
    printf("\n");
    for (int i = 0; i < N; i++)
    {
        printf("%d | ", i);
        for (int j = 0; j < N; j++)
        {
            printf(" %d | ", A[i][j]);

        }
        printf("\n   ");
       for(int k = 0; k<N; k++)
        {
            printf("-----");
        }
        printf("\n");
    }
}

bool isSafe(int N, int board[N][N], int row, int col)
{
    int i, j;

    /* Check this row on left side */
    for (i = 0; i < col; i++)
        if (board[row][i])
            return false;

    /* Check upper diagonal on left side */
    for (i = row, j = col; i >= 0 && j >= 0; i--, j--)
        if (board[i][j])
            return false;

    /* Check lower diagonal on left side */
    for (i = row, j = col; j >= 0 && i < N; i++, j--)
        if (board[i][j])
            return false;
    return true;
}

/* A recursive function to solve N
Queen problem using DFS*/
bool DFS(int N, int board[N][N], int depth)
{
    /* base case: If all queens are placed
    then print */
    if (depth >= N)
    {
        char ch;
        //printSolution(N, board);
        printf("\nSolution: \n");
        Display(N, board);
        printf("\nPress Enter Key for Next solution.");
        fflush(stdin);
        scanf("%c", &ch);
        printf("\n");
        return false;
    }

    /* Consider this column and try placing
    this queen in all rows one by one */
    for (int i = 0; i < N; i++) {
        /* Check if the queen can be placed on
        board[i][depth] */
        if (isSafe(N, board, i, depth)) {
            {/* Place this queen in board[i][depth] */
                char ch;
                board[i][depth] = 1;
            }
            DFS(N, board, depth + 1);

            /* If placing queen in board[i][col]
            doesn't lead to a solution, then
            remove queen from board[i][depth] */
            board[i][depth] = 0; // BACKTRACK
        }
    }

    /* If the queen cannot be placed in any row in
```

```
        this column col then return false */
    return false;
}

bool solveNQ(int N)
{
    int board[N][N];

    for(int i = 0 ; i<N; i++)
    {
        for(int j = 0; j<N; j++)
        {
            board[i][j] = 0;
        }
    }

    if (N == 2 || N == 3) {
        printf("Solution does not exist");
        return false;
    }
    DFS(N,board, 0);
    return true;
}

// main function
int main()
{
    int N = 0;
    printf("Input N: \n");
    scanf("%d", &N);
    solveNQ(N);
    return 0;
}
```

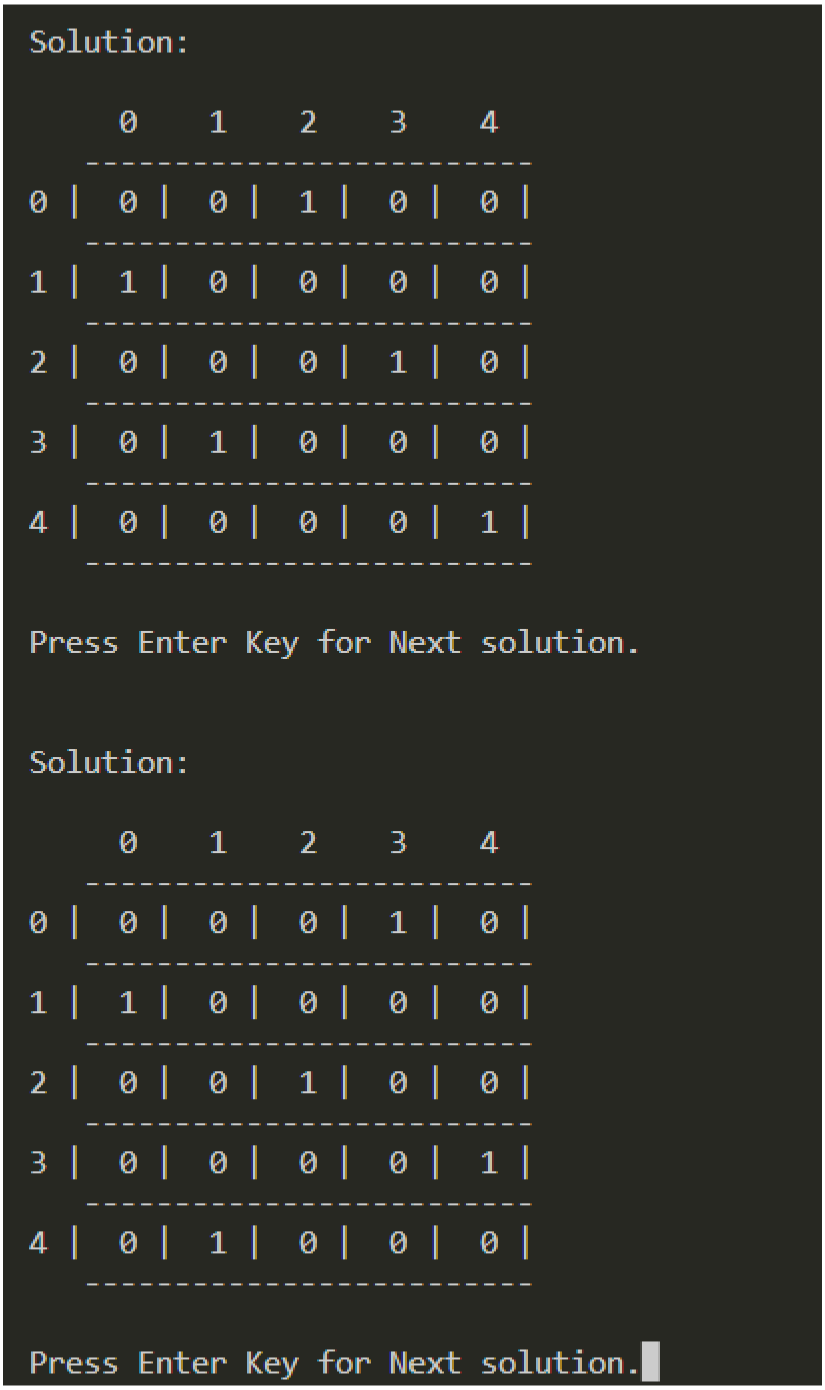
Result:



```
Input N:
4

Solution:

     0    1    2    3
   --------------------
0 |  0 |  0 |  1 |  0 |
   --------------------
1 |  1 |  0 |  0 |  0 |
   --------------------
2 |  0 |  0 |  0 |  1 |
   --------------------
3 |  0 |  1 |  0 |  0 |
   --------------------

Press Enter Key for Next solution.


Solution:

     0    1    2    3
   --------------------
0 |  0 |  1 |  0 |  0 |
   --------------------
1 |  0 |  0 |  0 |  1 |
   --------------------
2 |  1 |  0 |  0 |  0 |
   --------------------
3 |  0 |  0 |  1 |  0 |
   --------------------

Press Enter Key for Next solution.

PS D:\Code>
```



```
Input N:
5

Solution:

     0    1    2    3    4
   -------------------------
0 |  1 |  0 |  0 |  0 |  0 |
   -------------------------
1 |  0 |  0 |  0 |  1 |  0 |
   -------------------------
2 |  0 |  1 |  0 |  0 |  0 |
   -------------------------
3 |  0 |  0 |  0 |  0 |  1 |
   -------------------------
4 |  0 |  0 |  1 |  0 |  0 |
   -------------------------

Press Enter Key for Next solution.


Solution:

     0    1    2    3    4
   -------------------------
0 |  1 |  0 |  0 |  0 |  0 |
   -------------------------
1 |  0 |  0 |  1 |  0 |  0 |
   -------------------------
2 |  0 |  0 |  0 |  0 |  1 |
   -------------------------
3 |  0 |  1 |  0 |  0 |  0 |
   -------------------------
4 |  0 |  0 |  0 |  1 |  0 |
   -------------------------

Press Enter Key for Next solution.
```



```
Solution:

     0    1    2    3    4
   -------------------------
0 |  0 |  0 |  1 |  0 |  0 |
   -------------------------
1 |  1 |  0 |  0 |  0 |  0 |
   -------------------------
2 |  0 |  0 |  0 |  1 |  0 |
   -------------------------
3 |  0 |  1 |  0 |  0 |  0 |
   -------------------------
4 |  0 |  0 |  0 |  0 |  1 |
   -------------------------

Press Enter Key for Next solution.


Solution:

     0    1    2    3    4
   -------------------------
0 |  0 |  0 |  0 |  1 |  0 |
   -------------------------
1 |  1 |  0 |  0 |  0 |  0 |
   -------------------------
2 |  0 |  0 |  1 |  0 |  0 |
   -------------------------
3 |  0 |  0 |  0 |  0 |  1 |
   -------------------------
4 |  0 |  1 |  0 |  0 |  0 |
   -------------------------

Press Enter Key for Next solution.
```

…10 solutions in total for N = 5

Time Complexity: O(N^2 * N!)
Auxiliary Space: O(N)

Conclusion

The N-queens problem is solved by implementing backtracking technique.