K. J. Somaiya College of Engineering, Mumbai-77
(A Constituent College of Somaiya Vidyavihar University)
Department of Computer Engineering

Batch:- B-2 **Roll No :-** 16010122151

Experiment No. ___9___

Grade: AA / AB / BB / BC / CC / CD /DD

Signature of the Staff In-charge with date

Title: Implementation of N-Queen Problem using Backtracking Algorithm

Objective: To learn the Backtracking strategy of problem solving for 8-Queens problem

CO to be achieved:

Sr. No	Objective
CO 1	Compare and demonstrate the efficiency of algorithms using asymptotic complexity notations.
CO 2	Analyze and solve problems for divide and conquer strategy, greedy method, dynamic programming approach and backtracking and branch & bound policies.

Books/ Journals/ Websites referred:

1. **Ellis horowitz, Sarataj Sahni, S.Rajsekaran," Fundamentals of computer algorithm", University Press**
2. **T.H.Cormen ,C.E.Leiserson,R.L.Rivest and C.Stein," Introduction to algortihtms",2nd Edition ,MIT press/McGraw Hill,2001**
3. **http://www.math.utah.edu/~alfeld/queens/queens.html**
4. **http://www-isl.ece.arizona.edu/ece175/assignments275/assignment4a/Solving%208%20queen%20problem.pdf**
5. **http://www.slideshare.net/Tech_MX/8-queens-problem-using-back-tracking**
6. **http://www.mathcs.emory.edu/~cheung/Courses/170.2010/Syllabus/Backtracking/8queens.html**
7. **http://www.geeksforgeeks.org/backtracking-set-3-n-queen-problem/**
8. **http://www.hbmeyer.de/backtrack/achtdamen/eight.htm**

Pre Lab/ Prior Concepts:

Data structures, Concepts of algorithm analysis

Historical Profile:
The **N-Queens puzzle** is the problem of placing N queens on an N×N chessboard so that no two queens attack each other. Thus, a solution requires that no two queens share the same row, column, or diagonal.

New Concepts to be learned:
Application of algorithmic design strategy to any problem, Backtracking method of problem-solving Vs other methods of problem solving, 8- Queens problem and its applications.

Algorithm N Queens Problem: -

```
void NQueens(int k, int n)
// Using backtracking, this procedure prints all possible placements of n queens on an n X n chessboard so that they are nonattacking.
{       for (int i=1; i<=n; i++)
      {
             if (Place(k, i))
              {
                x[k] = i;
                if (k==n)
                         for (int j=1;j<=n;j++)          Print  x[j] ;
                else NQueens(k+1, n);
              }
        }
}

Boolean Place(int k, int i)
// Returns true if a queen can be placed in kth row and ith column.  Otherwise it returns false.
// x[] is a global array whose first (k-1) values have been set. abs(r) returns absolute value of r.
{
for (int j=1; j < k; j++)

        if ((x[j] == i)  // Two in the same column

      || (abs(x[j]-i) == abs(j-k)))                // or in the same diagonal

          return(false);

return(true);

 }
```

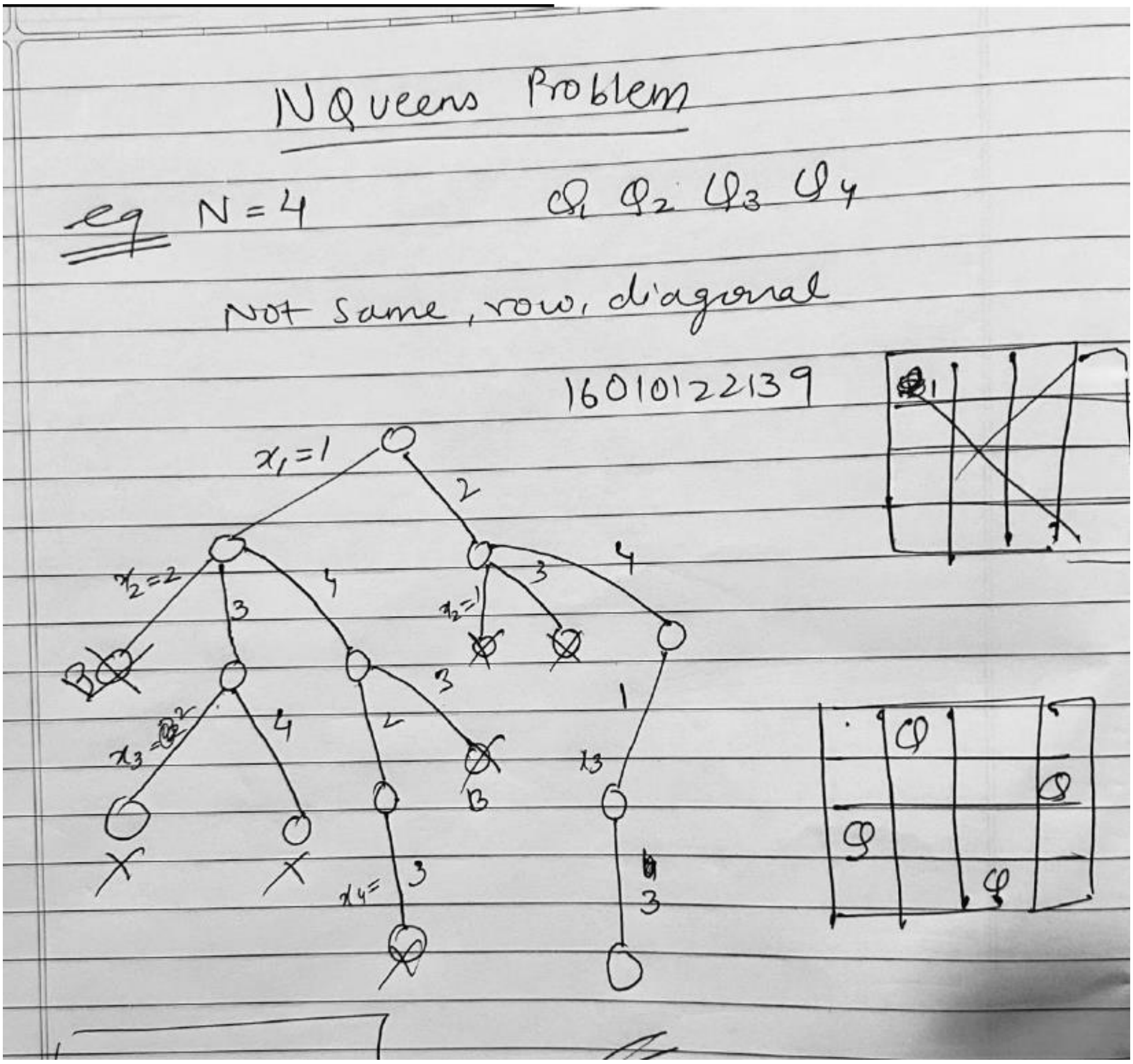
Example 8-Queens Problem:

The eight queens puzzle is the problem of placing eight chess queens on an 8×8 chessboard so that no two queens threaten each other i.e. no two queens share the same row, column, or diagonal.

Solution Using Backtracking Approach:

The idea is to place queens one by one in different columns, starting from the leftmost column. When we place a queen in a column, we check for clashes with already placed queens. In the current column, if we find a row for which there is no clash, we mark this row and column as part of the solution. If we do not find such a row due to clashes then we backtrack and return false.

State Space tree for N-Queens (Solution):



N Queens Problem

eg N = 4 Q_1 Q_2 Q_3 Q_4

Not same, row, diagonal

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Implementation (Code):

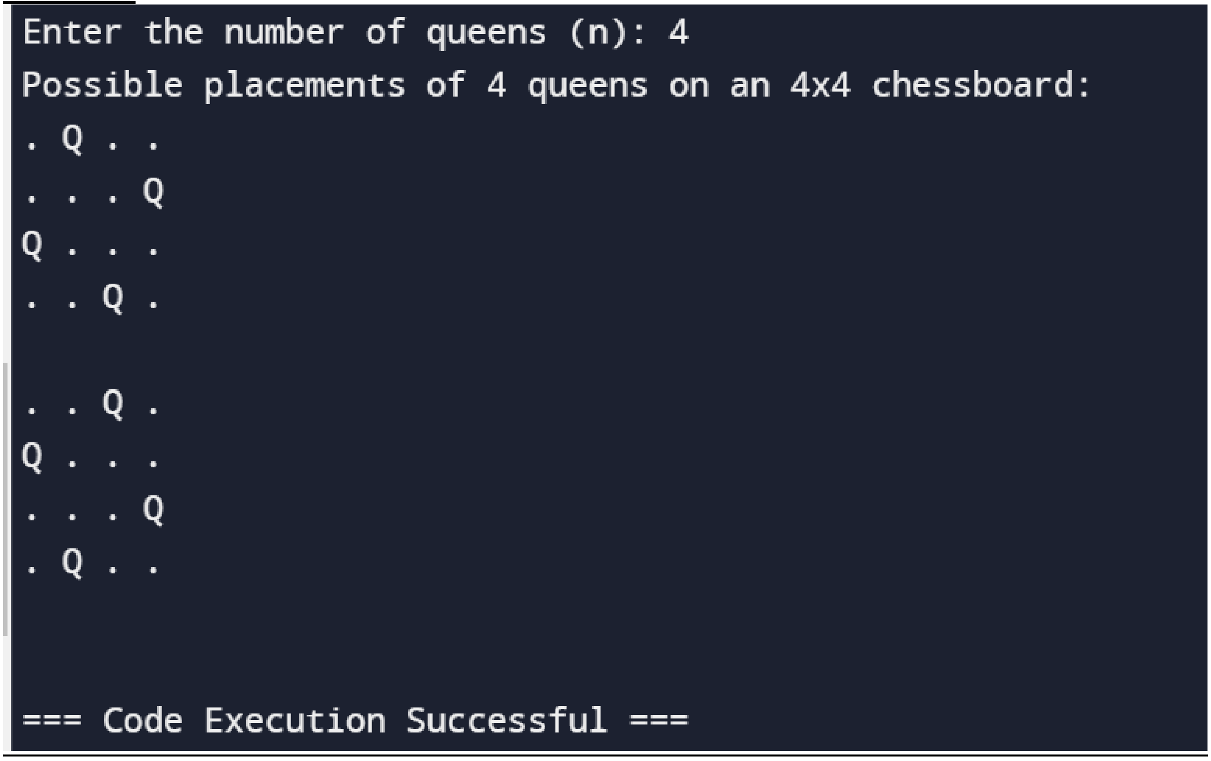
```
def print_board(x):
    """
    Prints the board layout based on the queen placements.
    """
    n = len(x) - 1  # Size of the board
    for row in range(1, n + 1):
        line = ""
        for col in range(1, n + 1):
            if x[row] == col:
                line += "Q "  # Place 'Q' for the queen
            else:
                line += ". "  # Place '.' for an empty square
        print(line)
    print()  # Print a blank line after each board layout

def n_queens(k, n, x):
    """
    Using backtracking, this function prints all possible placements of n
queens
    on an n x n chessboard so that they are nonattacking.
    """
    for i in range(1, n + 1):
        if place(k, i, x):
            x[k] = i
            if k == n:
                print_board(x)  # Print the solution board layout
            else:
                n_queens(k + 1, n, x)
            x[k] = 0  # Backtrack

def place(k, i, x):
    """
    Returns True if a queen can be placed in the kth row and ith column
without attacking any other queen.
    Otherwise, returns False.
    """
    for j in range(1, k):
        if x[j] == i or abs(x[j] - i) == abs(j - k):
            return False
    return True

if __name__ == "__main__":
    n = int(input("Enter the number of queens (n): "))
    x = [0] * (n + 1)  # x[k] represents the column index of the queen in the kth row
    print(f"Possible placements of {n} queens on an {n}x{n} chessboard:")
    n_queens(1, n, x)
```

OUTPUT:

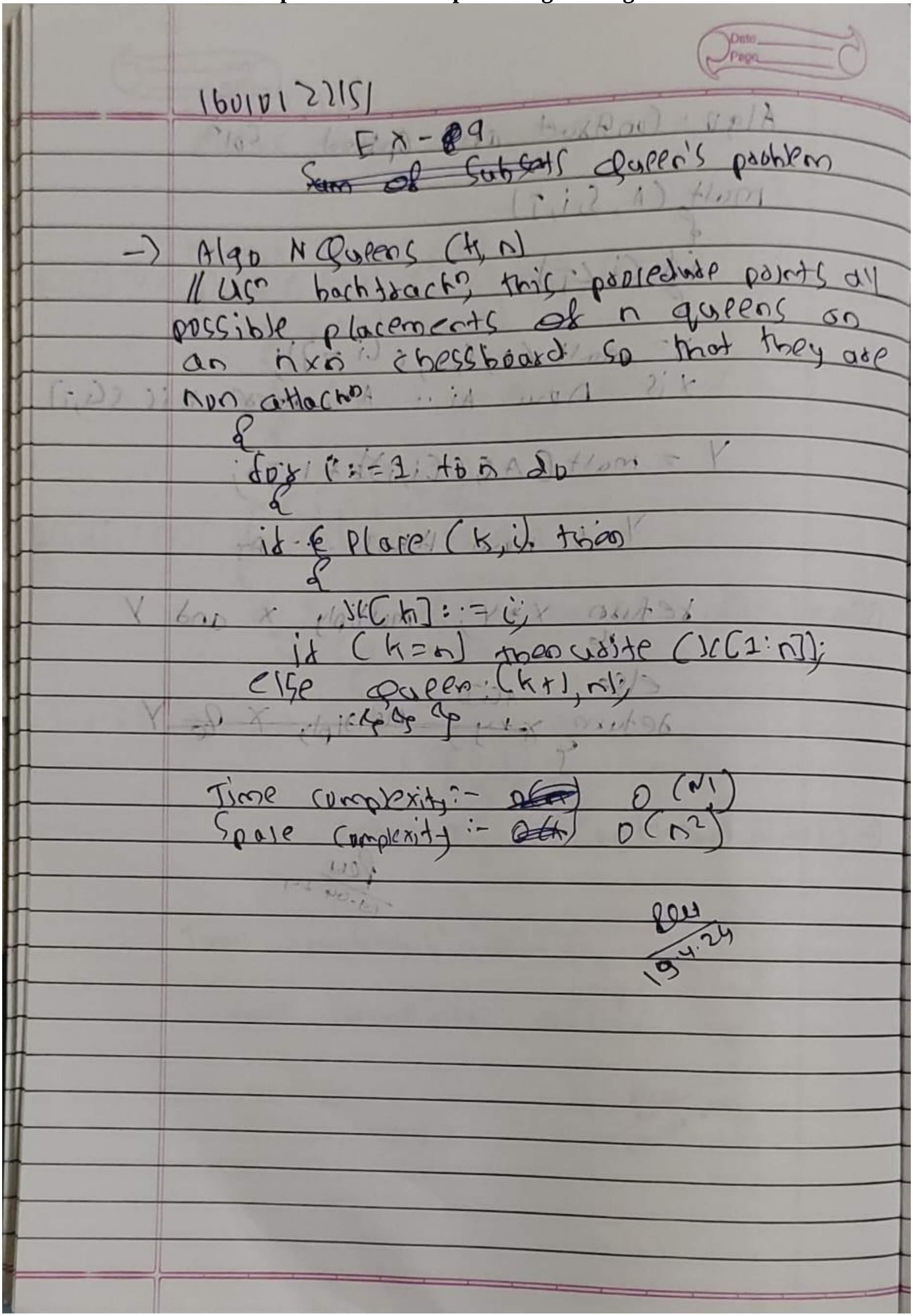


```
Enter the number of queens (n): 4
Possible placements of 4 queens on an 4x4 chessboard:
. Q . .
. . . Q
Q . . .
. . Q .

. . Q .
Q . . .
. . . Q
. Q . .


=== Code Execution Successful ===
```

Algorithm:



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Ex - 9

~~Sum of Subsets~~ Queen's problem

```
-> Algo NQueens (k, n)
// Using backtracking, this procedure prints all
possible placements of n queens on
an nxn chessboard so that they are
non attacking
  {
   for i := 1 to n do
    {
     if Place (k, i) then
      {
        x[k] := i;
        if (k = n) then write (x[1:n]);
     else Queen (k+1, n);
```

Time complexity :- O(N!)

Space complexity :- O(n^2)

19.4.24

Conclusion:-
Using both paper and code, we were able to solve the N queens algorithm and get accurate and comparable results.