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CSE-DS D1
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DAA Exp :- 7

AIM: Experiment based on backtracking strategy: N-Queens problem

Algorithm:
If two queens are placed at position (i, j) and (k, l).
Then they are on same diagonal only if (i - j) = k - l or i + j = k + l.
The first equation implies that j - l = i - k.
The second equation implies that j - l = k - i.
Therefore, two queens lie on the duplicate diagonal if and only if |j-l|=|i-k|
Place (k, i) returns a Boolean value that is true if the kth queen can be placed in column i.
x[] is a global array whose final k - 1 values have been set. Abs (r) returns the absolute value
of r.

```
Place (k, i)
{
 For j ← 1 to k - 1
 do if (x [j] = i) or (Abs (x [j]) – i)) == (Abs (j - k))
 then return false;
 return true;
}
N - Queens (k, n):
{
 For i ← 1 to n
 do if Place (k, i) then
 {
 x [k] ← i;
 if (k ==n) then
 write (x [1....n));
 else
 N - Queens (k + 1, n);
 }
}
```

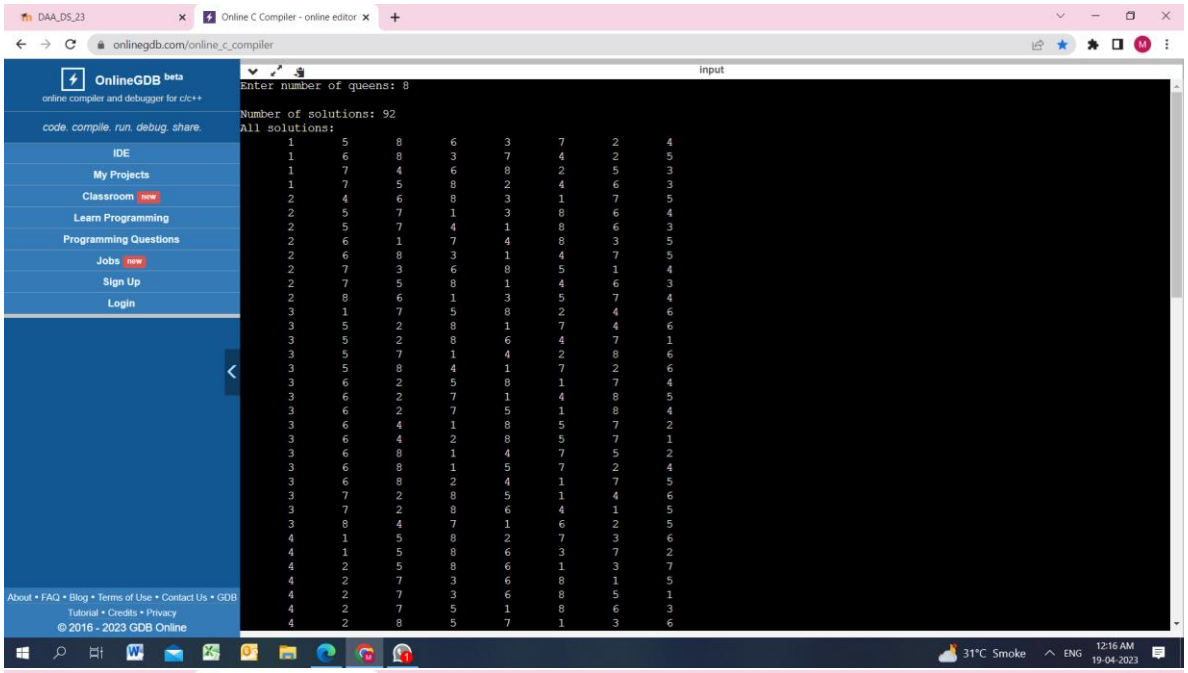
Code :-

```
#include <stdio.h>
#include <stdlib.h>
#include <stdbool.h>
#include <math.h>
int *
deepCopy (int *arr, int len)
{

int *newarr = malloc (sizeof (int) * len);
```

```
for (int i = 0; i < len; i++)

newarr[i] = arr[i];

return newarr;

}


int *
printArray (int *arr, int len)
{

for (int i = 0; i < len; i++)

printf ("%8d", arr[i]);

printf ("\n");

}

typedef struct node

{

int *data;

struct node *next;

} *pnode;

typedef struct list
{

pnode head;

pnode tail;

int n;

} *plist;

void
addNodetoList (plist l, int *data)
{

if (l->head != NULL)

    {

l->tail->next = malloc (sizeof (struct node));

l->tail = l->tail->next;

l->tail->next = NULL;
l->tail->data = data;

}

  else

    {

l->head = malloc (sizeof (struct node));

l->tail = l->head;

l->tail->next = NULL;

l->tail->data = data;

}
}
plist createList (int n)
{

plist l = malloc (sizeof (struct list));

l->head = NULL;

l->tail = NULL;

l->n = n;

return l;

}


typedef struct NQueensSolutions
{

int count;

plist solutions;                    // linked list of solutions
} *pNQueensSolutions;

void
printSolutions (pNQueensSolutions sol)
{

int n = sol->solutions->n;

printf ("\n");

for (pnode temp = sol->solutions->head; temp != NULL; temp =
temp->next)

printArray (temp->data, n);

}
```

```
bool queenCanBePlaced (int n, int k, int pos, int *curr_board)

{

int a, b;

for (int i = 1; i < k; i++)

    {

a = abs (i - k);                          // x1 - x2
      b = abs (curr_board[i - 1] - pos);   // y1 -y2
      if (a == b || a == 0 || b == 0)

return false;

}

return true;

}


void
placeKthQueen (int k, int n, int *curr_board, pNQueensSolutions
 solutions)
{

for (int i = 1; i <= n; i++)

    {

if (queenCanBePlaced (n, k, i, curr_board))

         {

curr_board[k - 1] = i;

if (k == n)                  // this is a complete solution
             {

addNodetoList (solutions->solutions,
deepCopy (curr_board, n));    // add a deep copy of current board to the list of solutions
              solutions->count++;

}

          else                               // place the next queen
            placeKthQueen (k + 1, n, curr_board, solutions);

}

}
}


pNQueensSolutions NQueens (int n)
{

pNQueensSolutions nqs = malloc (sizeof (struct NQueensSolutions));

nqs->count = 0;

nqs->solutions = createList (n);

int curr_board[n];

curr_board[0] = 1;

placeKthQueen (1, n, curr_board, nqs);

return nqs;

}


int
main ()
{

int n;

printf ("Enter number of queens: ");

scanf ("%d", &n);

pNQueensSolutions sol = NQueens (n);

printf ("\nNumber of solutions: %d\n", sol->count);

if (sol->count > 0)

    {

printf ("All solutions:");

printSolutions (sol);

}

}
```

OUTPUT:


DAA_DS_23
Online C Compiler - online editor
onlinegdb.com/online_c_compiler
OnlineGDB beta
online compiler and debugger for c/c++
code. compile. run. debug. share.
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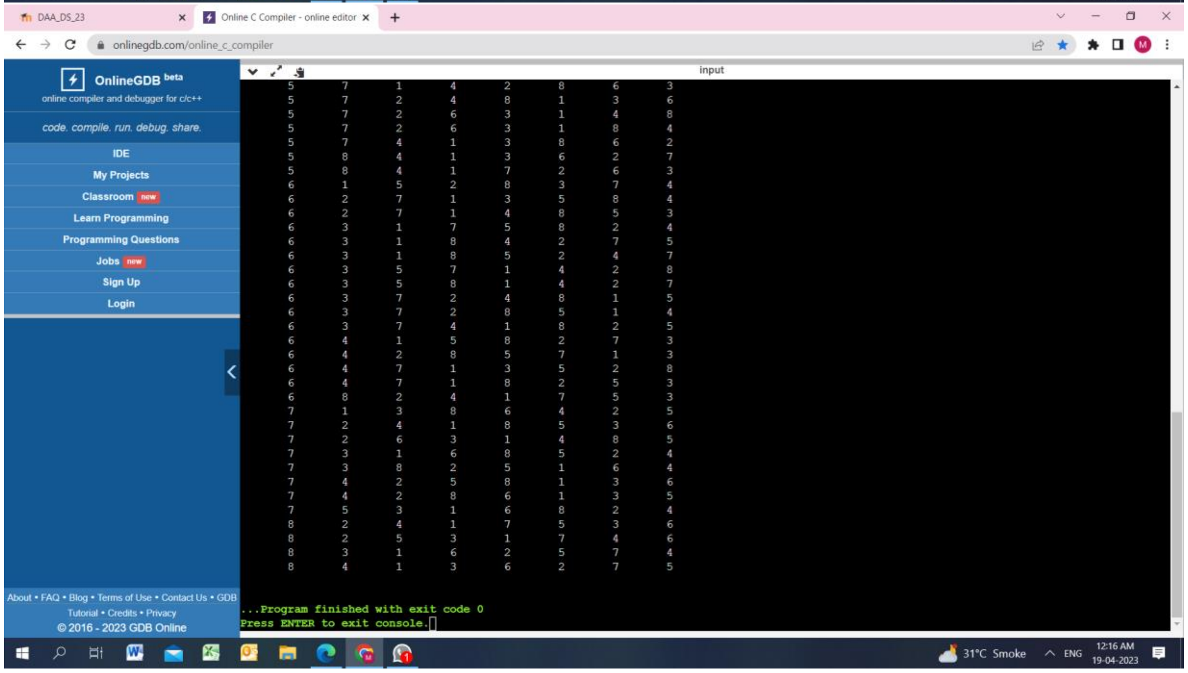
input
31°C Smoke
ENG
12:16 AM
19-04-2023

```
Enter number of queens: 8

Number of solutions: 92
All solutions:
       1       5       8       6       3       7       2       4
       1       6       8       3       7       4       2       5
       1       7       4       6       8       2       5       3
       1       7       5       8       2       4       6       3
       2       4       6       8       3       1       7       5
       2       5       7       1       3       8       6       4
       2       5       7       4       1       8       6       3
       2       6       1       7       4       8       3       5
       2       6       8       3       1       4       7       5
       2       7       3       6       8       5       1       4
       2       7       5       8       1       4       6       3
       2       8       6       1       3       5       7       4
       3       1       7       5       8       2       4       6
       3       5       2       8       1       7       4       6
       3       5       2       8       6       4       7       1
       3       5       7       1       4       2       8       6
       3       5       8       4       1       7       2       6
       3       6       2       5       8       1       7       4
       3       6       2       7       1       4       8       5
       3       6       2       7       5       1       8       4
       3       6       4       1       8       5       7       2
       3       6       4       2       8       5       7       1
       3       6       8       1       4       7       5       2
       3       6       8       1       5       7       2       4
       3       6       8       2       4       1       7       5
       3       7       2       8       5       1       4       6
       3       7       2       8       6       4       1       5
       3       8       4       7       1       6       2       5
       4       1       5       8       2       7       3       6
       4       1       5       8       6       3       7       2
       4       2       5       8       6       1       3       7
       4       2       7       3       6       8       1       5
       4       2       7       3       6       8       5       1
       4       2       7       5       1       8       6       3
       4       2       8       5       7       1       3       6
```



```
       5       7       1       4       2       8       6       3
       5       7       2       4       8       1       3       6
       5       7       2       6       3       1       4       8
       5       7       2       6       3       1       8       4
       5       7       4       1       3       8       6       2
       5       8       4       1       3       6       2       7
       5       8       4       1       7       2       6       3
       6       1       5       2       8       3       7       4
       6       2       7       1       3       5       8       4
       6       2       7       1       4       8       5       3
       6       3       1       7       5       8       2       4
       6       3       1       8       4       2       7       5
       6       3       1       8       5       2       4       7
       6       3       5       7       1       4       2       8
       6       3       5       8       1       4       2       7
       6       3       7       2       4       8       1       5
       6       3       7       2       8       5       1       4
       6       3       7       4       1       8       2       5
       6       4       1       5       8       2       7       3
       6       4       2       8       5       7       1       3
       6       4       7       1       3       5       2       8
       6       4       7       1       8       2       5       3
       6       8       2       4       1       7       5       3
       7       1       3       8       6       4       2       5
       7       2       4       1       8       5       3       6
       7       2       6       3       1       4       8       5
       7       3       1       6       8       5       2       4
       7       3       8       2       5       1       6       4
       7       4       2       5       8       1       3       6
       7       4       2       8       6       1       3       5
       7       5       3       1       6       8       2       4
       8       2       4       1       7       5       3       6
       8       2       5       3       1       7       4       6
       8       3       1       6       2       5       7       4
       8       4       1       3       6       2       7       5


...Program finished with exit code 0
Press ENTER to exit console.
```

.