HPC PROJECT REPORT

N QUEENS PROBLEM

Submitted By

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- **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. Thus, a solution requires that no two queens share the same row, column, or diagonal. The eight queens puzzle is an example of the more general *n* queens problem of placing *n* non-attacking queens on an *n*×*n* chessboard, for which solutions exist for all natural numbers *n* with the exception of *n*=2 and *n*=3.

- **Code**

```
/*
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compile: g++ -fopenmp -o nqueens 4n_queens.c
run:       ./nqueens number_of_queens number_of_threads
eg. ./nqueens 8 1
Here, 8 is the number of queens and 1 is the number of thread to execute
*/

#include <stdio.h>
#include <stdlib.h>
#include <stdbool.h>
#include <time.h>
#include <sys/time.h>
#include <omp.h>

#define MAX_N 16
void print_solution(int queen_rows[ ], int n)
{
        #pragma omp critical
   {
            printf("\n");
            for (int i = 0; i < n; i++)
            {
               int j;
                    for (j = 0; j < n; j++)
                    {
                              if (queen_rows[i] == j)
                                    printf("|X");
                              else
```

```
                                printf("| ");
                        }
                        printf("|\n");
                }
                printf("\n");
        }
}

int check_for_clash(int queen_rows[MAX_N], int n)
{
        int i, j;
        for (i = 0; i < n; i++)
        {
                for (j = i+1; j < n; j++)
                {
                        // two queens in the same row or column -> not a solution!
                        if (queen_rows[i] == queen_rows[j])
                                return 0;

                        // two queens in the same diagonal -> not a solution!
                        if (queen_rows[i] - queen_rows[j] == i - j ||
                            queen_rows[i] - queen_rows[j] == j - i)
                            return 0;
                }
        }

        return 1;
}

int main(int argc, char* argv[])
{
        //number_of_queens
        int n;

    int max_iter = 1;

    double start_time, end_time;
    int num_sol = 0;

        {
            //number of threads
            int num_workers;
```

```
    int i;

    n = (argc > 1) ? atoi(argv[1]) : 8;
    num_workers = (argc > 2) ? atoi(argv[2]) : 30;

    omp_set_num_threads(num_workers);

    for (i = 0; i < n; i++)
    {
        max_iter *= n;
    }
}

start_time = omp_get_wtime();

        int iter;
        #pragma omp parallel
        {
                #pragma omp for
                for (iter = 0; iter < max_iter; iter++)
                {
                        int code = iter;
                        int i;
                int queen_rows[MAX_N];

                        for (i = 0; i < n; i++)
                        {
                                queen_rows[i] = code % n;
                                code /= n;
                        }
                        if (check_for_clash(queen_rows, n))
                        {
                                #pragma omp atomic
                                    num_sol++;
                                //print_solution(queen_rows,n);
                        }
                }
        }

// get end time
end_time = omp_get_wtime();
// print results
printf("The execution time is %g sec\n", end_time - start_time);
```

```
    printf("Number of found solutions is %d\n", num_sol);

        return 0;
}
```

- **Output**

```
File  Edit  View  Search  Terminal  Help
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> g++ -fopenmp -o nqueens 4bnb_queens.c
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> SSSSSSSSSSSSSSSS./nqueens 8 1
bash: SSSSSSSSSSSSSSSS./nqueens: No such file or directory
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 2
The execution time is 0.878807 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 4
The execution time is 0.58206 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 6
The execution time is 0.589564 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 8
The execution time is 0.588187 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 10
The execution time is 0.598609 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 12
The execution time is 0.597443 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 14
The execution time is 0.582415 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 18
The execution time is 0.58607 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 22
The execution time is 0.584177 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 26
The execution time is 0.582229 sec
Number of found solutions is 92
```

```
File  Edit  View  Search  Terminal  Help
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 26
The execution time is 0.582229 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 30
The execution time is 0.584046 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 34
The execution time is 0.591134 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 38
The execution time is 0.617787 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 42
The execution time is 0.595761 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 46
The execution time is 0.599165 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 50
The execution time is 0.592757 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 54
The execution time is 0.584749 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 58
The execution time is 0.586939 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 62
The execution time is 0.583666 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
> ./nqueens 8 1
The execution time is 1.72103 sec
Number of found solutions is 92
yutika@kulwe ~/Desktop/HPC lab/project $  Tue Oct-16 10:59:09pm
```

- **Graph:**

Threads	Time_taken
1	1.72103
2	0.878807
4	0.878807
6	0.589564
8	0.588187
10	0.598609
12	0.597443
14	0.582415
18	0.58607
22	0.584177
26	0.582229
30	0.584046
34	0.591134
38	0.617787
42	0.595761
46	0.599165
50	0.592757
54	0.584749
58	0.586939
62	0.583666
p	26
T(p)	0.582229
T(1)	1.72103
parallel fraction	0.68816525