Programming Assignment 2:
Validating Sudoku Solution

Design of the program:

- The values of N(size of sudoku), K(no. of threads) and the values of sudoku are taken from input.txt(input file)
- Clock is started to calculate the time taken to complete the process before the. K no. of threads are created using a loop and they are given the task of function "runner". For OpenMP, the no. of threads are set to K.
- There are 5 functions. sqroot(calculates square root of a number), row_valid(checks the validity of a row in sudoku), col_valid(checks the validity of a column in sudoku), sub_valid(checks the validity of a subgrid in sudoku), runner(the function that threads work on) and the main function.
- Working of row_valid, col_valid and sub_valild functions: Each function has an array with size N initialized to 0 to check if all the N numbers are there in that row or column or subgrid. If the number is there that particular number-1 index will be marked one. If the number is greater than N or less than 1 or is already present then the function returns -1. Else the function returns that particular row or column or subgrid number.
- A structure called thread_info is created which stores the start column, row or subgrid number and also the number of rows, columns and subgrids that particular thread should check. It also has should_terminate which stores the value 1 if the thread should terminate early.
- Another structure is created to store the output
- Working of runner function: Runner funcion takes thread_info threads form the main function and uses its data. Function row_valid, col_valid and sub_valid are called based on the information that runner function receives(nrow: no. of row,

ncol: no. of columns and nsub:no. Of subgrid). If something is found invalid the thread exits.

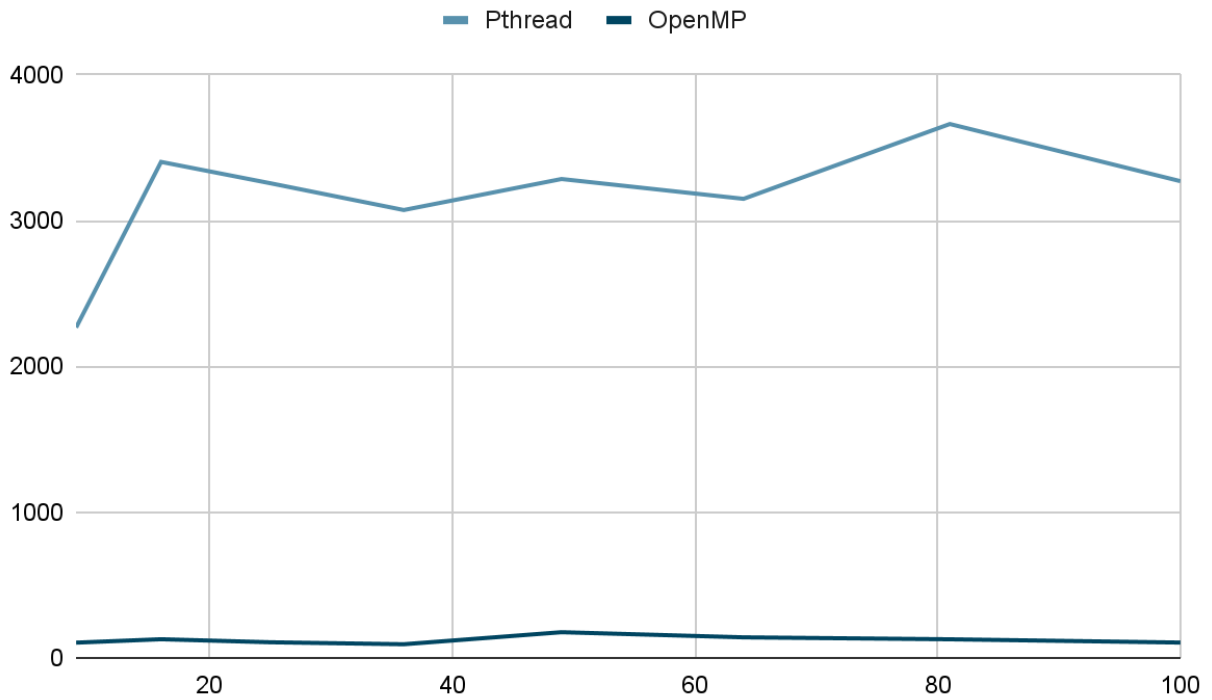## Analysis of the output:

Plot1 - Time taken vs Size of sudoku:

Total number of threads is fixed as 16.

X-axis: size of sudoku

Y-axis: Time

Size of sudoku(N)	Time-pthread	Time-OpenMP
9	2266.8	104.6
16	3403	128
25	3256.6	107.2
36	3072.8	93.6
49	3285.6	176.2
64	3149.6	141
81	3663	127.6
100	3270.8	105.2

Note: The above values of time are an average of five trails for the same no. of threads.

Plot2 - Time taken vs Number of threads:

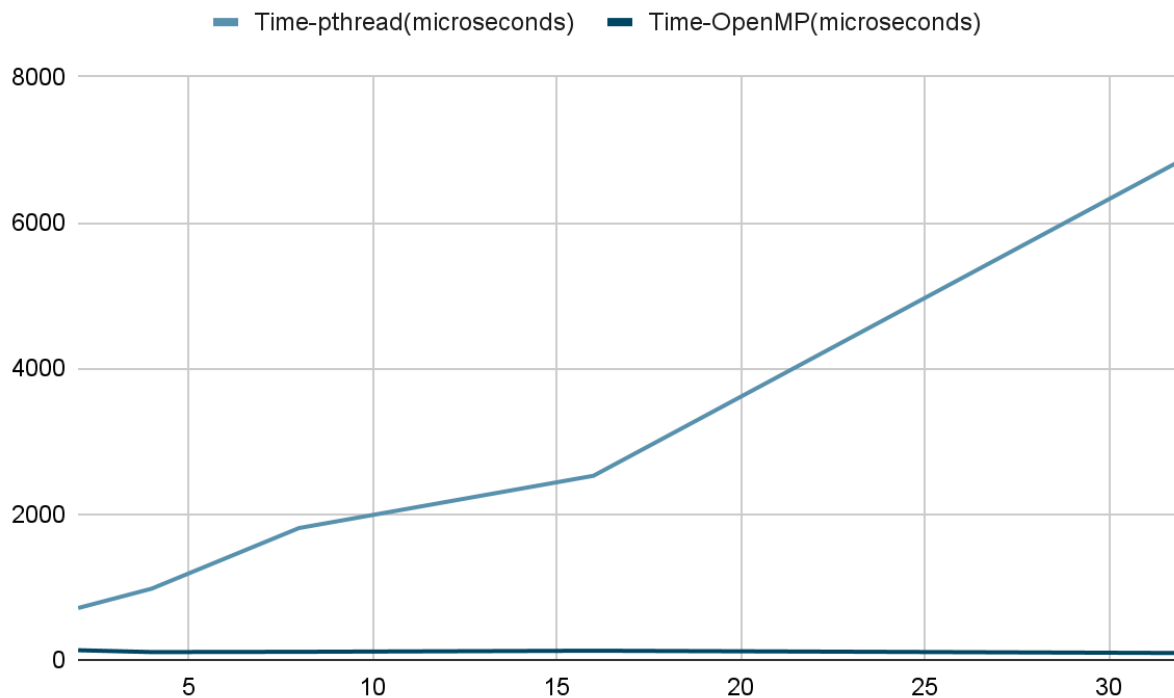The size of sudoku is fixed to 25.

X-axis: No. of threads

Y-axis: Time

No. of threads	Time-pthread(microseconds)	Time-OpenMP(microseconds)
2	711.4	132.4
4	977.8	107.2
8	1809	110.8
16	2526.4	125.8

| 32 | 6863.2 | 94 |

Note: The above values of time are an average of five trails for the same size of sudoku

Analysis of the results:

Since the no. of cores a system has will be less than the no. of threads we use, the time can increase. We can see that the time is not changing much for OpenMP even when the size of sudoku and no. of threads are changed when compared to pthread.