Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram

High Performance Computing Practice - COM403P

EXPERIMENT 3

Name	Roll Number
N Sree Dhyuti	CED19I027

Matrix Addition

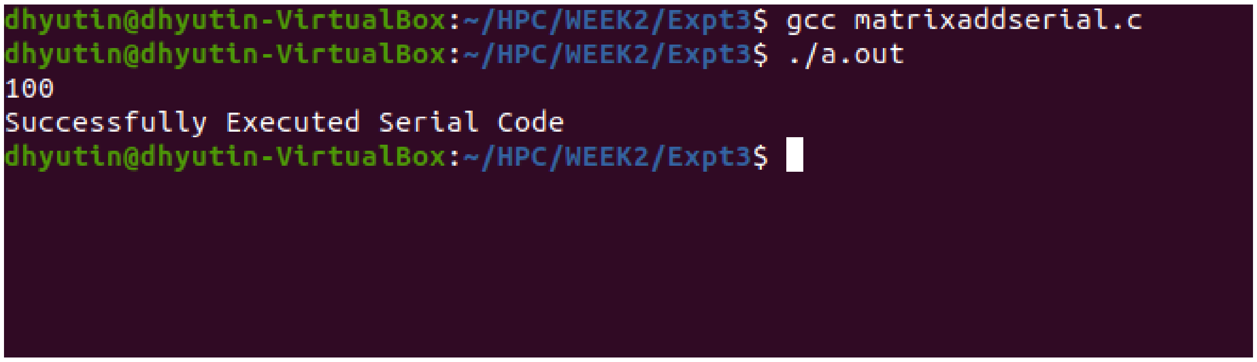
OBJECTIVE:

1. Perform matrix addition on ‘n^2’ double precision floating point numbers of two n X n matrices

Serial Code:

```
#include <stdio.h>
#include <math.h>
#include <stdlib.h>
#include "omp.h"

int main(){

        int n;
        scanf("%d", &n);

        double v1[n][n], v2[n][n], ans[n][n];

        for(int i = 0; i < n; i++){
        for(int j = 0; j < n; j++){
        v1[i][j] = (float)rand()/(float)(RAND_MAX/n);
        v2[i][j] = (float)rand()/(float)(RAND_MAX/n);
        ans[i][j] = 0;
        }

        }

        for(int i = 0; i < n; i++){
        for(int j = 0; j < n; j++){
        ans[i][j] = v1[i][j] + v2[i][j];
        }
        }
        printf("Successfully Executed Serial Code\n");

        return 0;
}
```

Output:



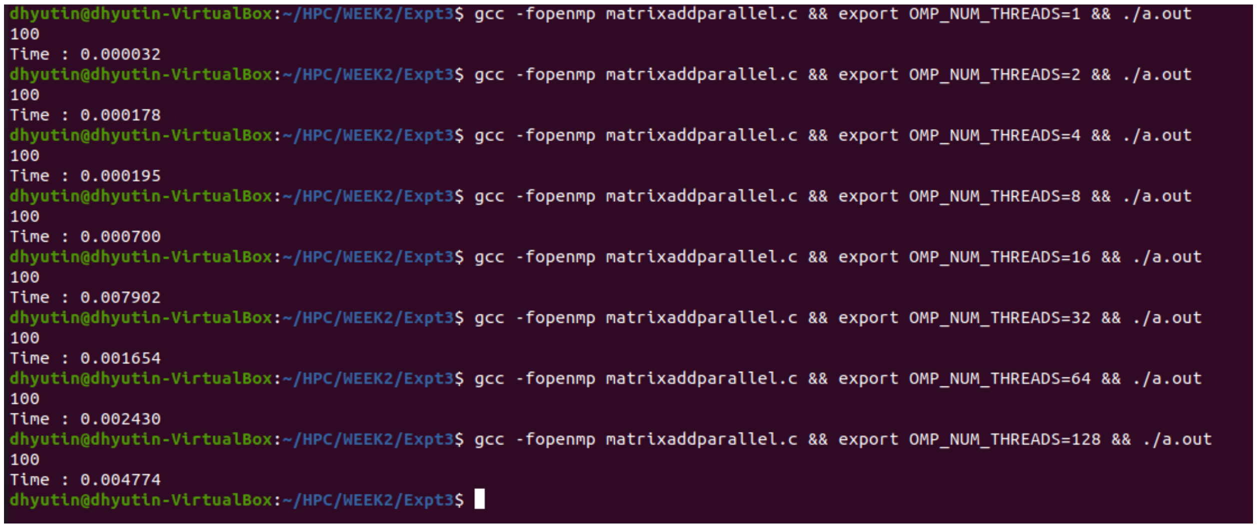
```
dhyutin@dhyutin-VirtualBox:~/HPC/WEEK2/Expt3$ gcc matrixaddserial.c
dhyutin@dhyutin-VirtualBox:~/HPC/WEEK2/Expt3$ ./a.out
100
Successfully Executed Serial Code
dhyutin@dhyutin-VirtualBox:~/HPC/WEEK2/Expt3$
```

Parallelized Code:

```
#include <stdio.h>
#include <stdlib.h>
#include "omp.h"

int main(){

        int n;
        scanf("%d", &n);

        double v1[n][n], v2[n][n], ans[n][n];

        for(int i = 0; i < n; i++){
```

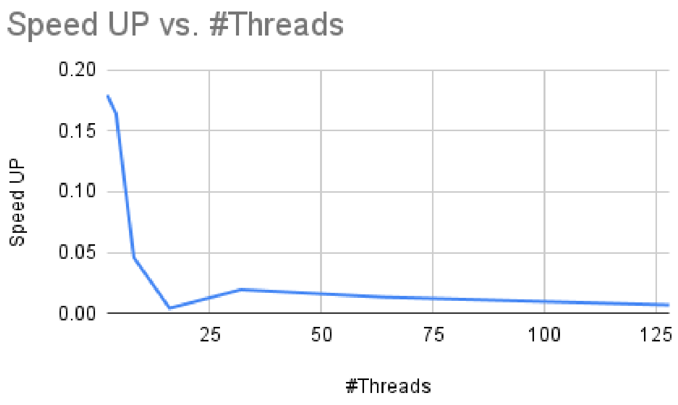
```
        for(int j = 0; j < n; j++){
        v1[i][j] = (float)rand()/(float)(RAND_MAX/n);
        v2[i][j] = (float)rand()/(float)(RAND_MAX/n);
        ans[i][j] = 0;
        }

        }

        double wallclock_initial = omp_get_wtime();
        #pragma omp parallel
        {
        int id = omp_get_thread_num();
        printf("Thread No - %d\n", id);
        #pragma omp for collapse(2)
        for(int i = 0; i < n; i++){
        // #pragma omp for
        for(int j = 0; j < n; j++){
                ans[i][j] = v1[i][j] + v2[i][j];
        }
        }
        }
        double wallclock_final = omp_get_wtime();

        printf("Time : %lf\n", wallclock_final - wallclock_initial);
        return 0;
}
```

Output:



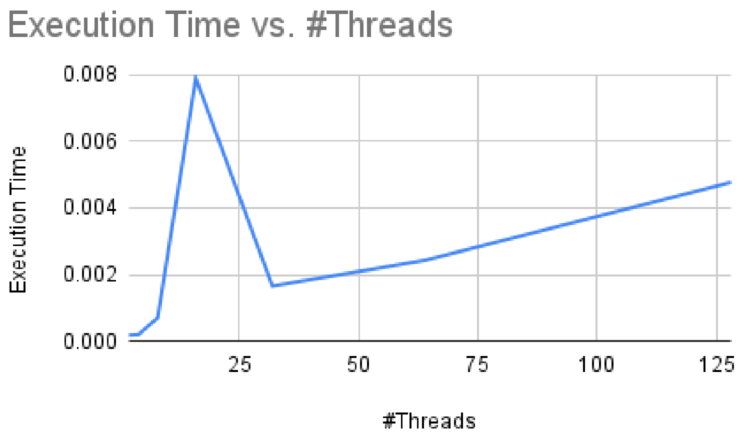
```
dhyutin@dhyutin-VirtualBox:~/HPC/WEEK2/Expt3$ gcc -fopenmp matrixaddparallel.c && export OMP_NUM_THREADS=1 && ./a.out
100
Time : 0.000032
dhyutin@dhyutin-VirtualBox:~/HPC/WEEK2/Expt3$ gcc -fopenmp matrixaddparallel.c && export OMP_NUM_THREADS=2 && ./a.out
100
Time : 0.000178
dhyutin@dhyutin-VirtualBox:~/HPC/WEEK2/Expt3$ gcc -fopenmp matrixaddparallel.c && export OMP_NUM_THREADS=4 && ./a.out
100
Time : 0.000195
dhyutin@dhyutin-VirtualBox:~/HPC/WEEK2/Expt3$ gcc -fopenmp matrixaddparallel.c && export OMP_NUM_THREADS=8 && ./a.out
100
Time : 0.000700
dhyutin@dhyutin-VirtualBox:~/HPC/WEEK2/Expt3$ gcc -fopenmp matrixaddparallel.c && export OMP_NUM_THREADS=16 && ./a.out
100
Time : 0.007902
dhyutin@dhyutin-VirtualBox:~/HPC/WEEK2/Expt3$ gcc -fopenmp matrixaddparallel.c && export OMP_NUM_THREADS=32 && ./a.out
100
Time : 0.001654
dhyutin@dhyutin-VirtualBox:~/HPC/WEEK2/Expt3$ gcc -fopenmp matrixaddparallel.c && export OMP_NUM_THREADS=64 && ./a.out
100
Time : 0.002430
dhyutin@dhyutin-VirtualBox:~/HPC/WEEK2/Expt3$ gcc -fopenmp matrixaddparallel.c && export OMP_NUM_THREADS=128 && ./a.out
100
Time : 0.004774
dhyutin@dhyutin-VirtualBox:~/HPC/WEEK2/Expt3$
```

Speedup V/S Number of Processors:



Inference:
It can be inferred from the above graph that till a threshold of 16 threads(16 processors), speedup value is decreasing and it increases till 64 threads and decreases.
Similar to the previous experiments, it is evident that this isn't a computationally expensive task and thus single thread execution is the most optimum one to choose to attain results soon.

Execution Time V/S Number of Threads:



Inference:
It can be inferred from the above graph that till a threshold of 16 threads(16 processors), Execution time is increasing and it decreases till 64 threads and increases.
Similar to the previous experiments, it is evident that this isn't a computationally expensive task and thus single thread execution is the most optimum one to choose to attain results soon.

Parallelization Factor (f):

#Threads	Execution Time	Speed UP	Efficiency (in %)	f
1	0.000032	1	100	n/a
2	0.000178	0.1797752809	8.988764045	-9.125
4	0.000195	0.1641025641	4.102564103	-6.791666667
8	0.0007	0.04571428571	0.5714285714	-23.85714286
16	0.007902	0.004049607694	0.02531004809	-262.3333333
32	0.001654	0.01934703748	0.06045949214	-52.32258065
64	0.00243	0.01316872428	0.02057613169	-76.12698413
128	0.004774	0.006702974445	0.005236698785	-149.3543307

Inference:
Considering that single thread execution is the most optimum for this program, it is clear that ‘f’ value will be in negative for any number of threads apart from 1. Same trend of decreasing till 16 threads and increasing till 64 threads and further decreasing is noticed for values of ‘f’ also.

THE END