# PARALLEL AND DISTRIBUTED COMPUTING

# LAB 2

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L43+L44

## AIM

Compare the time taken when matrix addition is serialized and parallelized using Amdahl’s Law to calculate the speedup.

## CODE

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

#define ROWS 2500
#define COLS 250

int main()
{
   int a[ROWS][COLS],b[ROWS][COLS],c[ROWS][COLS];

   for(int i=0;i<ROWS;++i)
   for(int j=0;j<COLS;++j)
   {
      a[i][j]=i*10+j;
      b[i][j]=j*10+i;
   }

   float start=omp_get_wtime();

   #pragma omp parallel for shared(a,b,c) //reduction(+: c)
   for(int i=0;i<ROWS;++i)
   for(int j=0;j<COLS;++j)
   {
      c[i][j]=a[i][j]+b[i][j];
   }
   float end=omp_get_wtime();
   float exec=end-start;

   printf("Time taken %f\n",exec);
   return 0;
}
```

## EXECUTION

**Bash commands:**

export OMP_NUM_THREADS=2
gcc -fopenmp prog.c
./a.out
*Note*: For Sequential, OMP_NUM_THREADS=1

## RESULTS

We see that serial execution takes a lot longer than most of the parallelized implementations. The average execution time reduces as the number of threads increase from 2 to 6. But, from thread count 8, we see a general increase in the time taken to execute matrix addition. The observations are recorded in the table below.

```
shyam@shyam-Inspiron-14-5408:~/Academics/Labs/PDC/Lab2$ export OMP_NUM_THREADS=1
shyam@shyam-Inspiron-14-5408:~/Academics/Labs/PDC/Lab2$ gcc -fopenmp matadd.c
shyam@shyam-Inspiron-14-5408:~/Academics/Labs/PDC/Lab2$ ./a.out
Time taken 0.009766
shyam@shyam-Inspiron-14-5408:~/Academics/Labs/PDC/Lab2$ ./a.out
Time taken 0.007812
shyam@shyam-Inspiron-14-5408:~/Academics/Labs/PDC/Lab2$ ./a.out
Time taken 0.007812
shyam@shyam-Inspiron-14-5408:~/Academics/Labs/PDC/Lab2$ ./a.out
Time taken 0.007812
```


```
shyam@shyam-Inspiron-14-5408:~/Academics/Labs/PDC/Lab2$ export OMP_NUM_THREADS=1
shyam@shyam-Inspiron-14-5408:~/Academics/Labs/PDC/Lab2$ gcc -fopenmp matadd.c
shyam@shyam-Inspiron-14-5408:~/Academics/Labs/PDC/Lab2$ ./a.out
Time taken 0.009766
shyam@shyam-Inspiron-14-5408:~/Academics/Labs/PDC/Lab2$ ./a.out
Time taken 0.007812
shyam@shyam-Inspiron-14-5408:~/Academics/Labs/PDC/Lab2$ ./a.out
Time taken 0.007812
shyam@shyam-Inspiron-14-5408:~/Academics/Labs/PDC/Lab2$ ./a.out
Time taken 0.007812
```


## TABLE

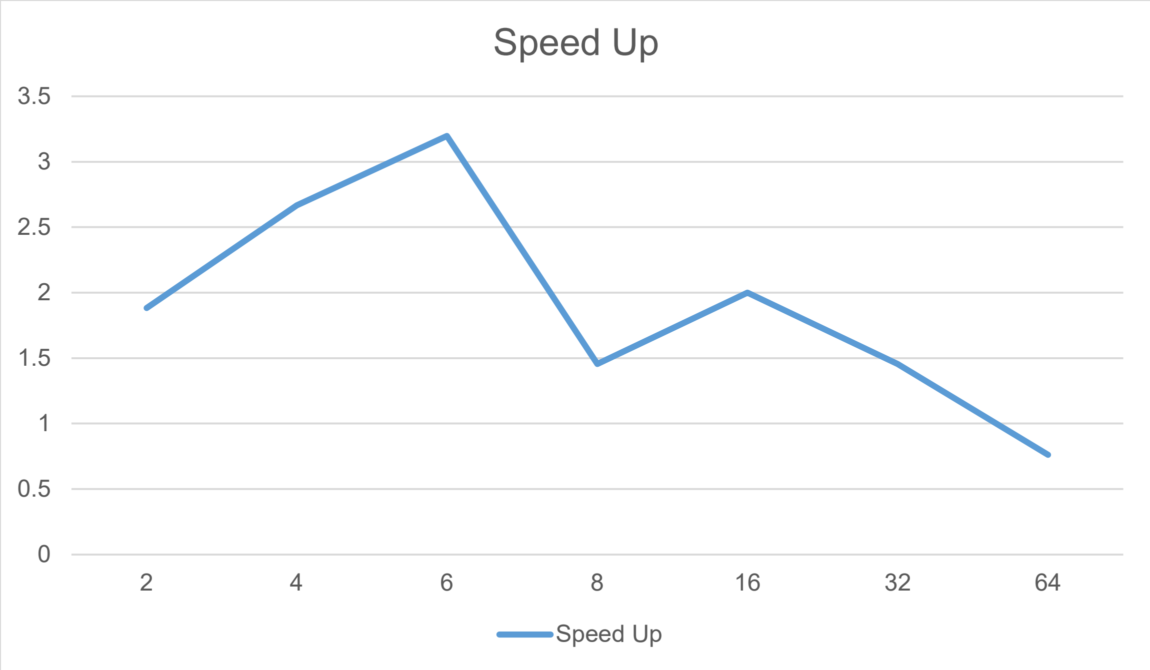
| Thread Count | Execution Time 1 | Execution Time 2 | Execution Time 3 | Execution Time 4 | Average Execution Time |
|---|---|---|---|---|---|
| 1 | 0.009766 | 0.007812 | 0.011719 | 0.001953 | 0.007812 |
| 2 | 0.003906 | 0.003906 | 0.003906 | 0.004883 | 0.004150 |
| 4 | 0.001953 | 0.003906 | 0.001953 | 0.003906 | 0.002930 |
| 6 | 0.001953 | 0.001953 | 0.003906 | 0.001953 | 0.002443 |
| 8 | 0.001953 | 0.001953 | 0.001953 | 0.015625 | 0.005371 |
| 16 | 0.003906 | 0.003906 | 0.003906 | 0.003906 | 0.003906 |
| 32 | 0.003906 | 0.005859 | 0.005859 | 0.005859 | 0.005371 |
| 64 | 0.005859 | 0.019531 | 0.007812 | 0.007812 | 0.010226 |

| Thread Count | PF | Speed Up |
|---|---|---|
| 2 | 0.937532 | 1.88241 |
| 4 | 0.833248 | 2.66621 |
| 6 | 0.824731 | 3.19771 |
| 8 | 0.357106 | 1.45448 |
| 16 | 0.533333 | 1.99999 |
| 32 | 0.322548 | 1.45447 |
| 64 | -0.313917 | 0.76394 |

We see that the optimal number of threads is 6, so p=6.
$T_p$=0.002443 and $T_1$=0.007812. Thus, PF = $(1 - \frac{Tp}{T1})/(1 - \frac{1}{p})$ = 0.824731

From Amdahl's law, speedup = $1/(s + \frac{p}{n})$, where p = PF, s=1-p and n=optimal num of threads which here is 6. Which gives us a speedup = 3.197706.

## GRAPH




## CONCLUSION

We have thus calculated the speed up to be nearly 3.2 when parallelizing the problem of matrix addition for large matrices.