High Performance Computing

COM403P

Experiment-3

Matrix Addition

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Objective

Matrix Addition for given n x n double precision floating point numbers.

Serial Code

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

#define SIZE 100

int main()
{
    double a[SIZE][SIZE], b[SIZE][SIZE], c[SIZE][SIZE], rand_a, rand_b;
    double start, end, exec;

    start = omp_get_wtime();

    for (int i = 0; i < SIZE; i++)
    {
        for(int j = 0; j < SIZE; j++)
        {
            rand_a = rand();
            rand_b = rand();

            a[i][j] = i*rand_a;
            b[i][j] = i*rand_b;

            for(int k = 0; k < 100000; k++)
            c[i][j] = a[i][j] + b[i][j];
        }
    }

    end = omp_get_wtime();

    exec = end - start;

    printf("Serial Exec time - %f\n", exec);

    return 0;
}
```

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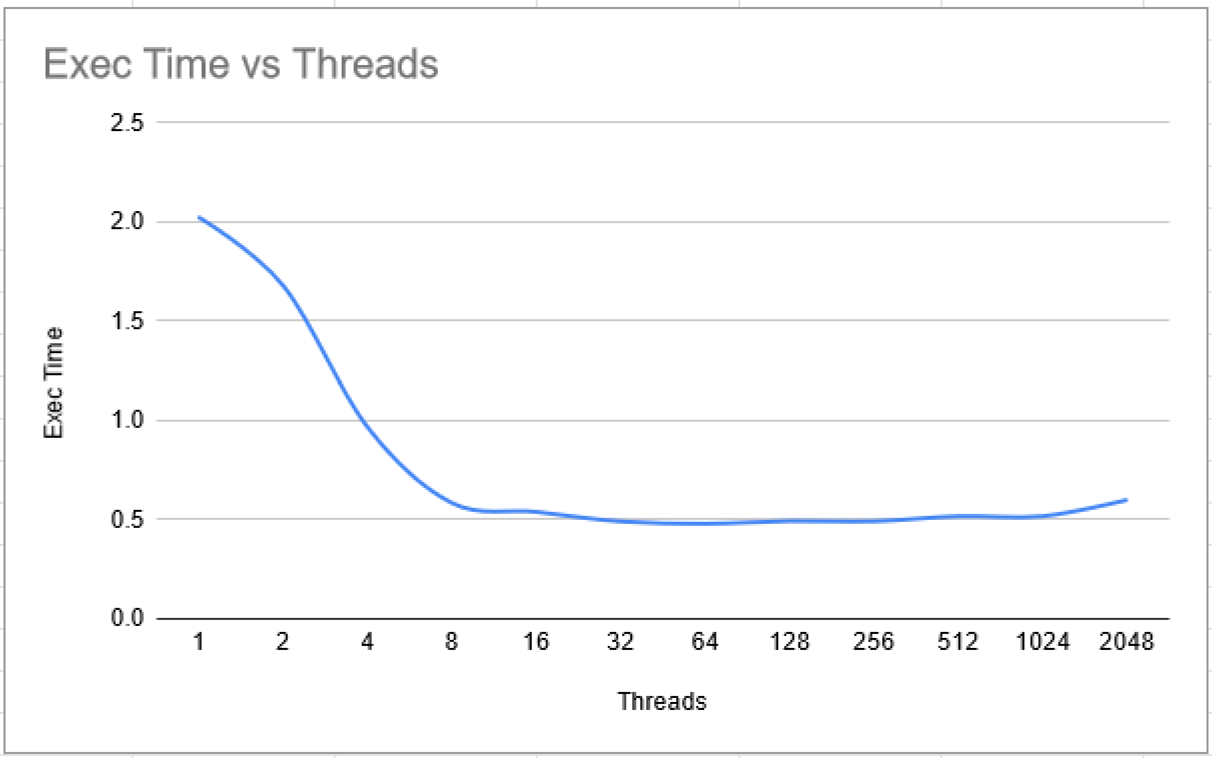
Parallel Code

```c
#include <stdio.h>
#include <stdlib.h>
#include <omp.h>
#include <time.h>

#define SIZE 100

int main()
{
    double a[SIZE][SIZE], b[SIZE][SIZE], c[SIZE][SIZE], rand_a, rand_b;
    double start, end, exec;
    int i, j;

    start = omp_get_wtime();
    int thread;

    #pragma omp parallel private(j) shared(c)
    {
        thread = omp_get_num_threads();
        #pragma omp for
        for (i = 0; i < SIZE; i++)
        {
            for(j = 0; j < SIZE; j++)
            {
                rand_a = rand();
                rand_b = rand();

                a[i][j] = i*rand_a;
                b[i][j] = i*rand_b;

                for(int k = 0; k < 100000; k++)
                c[i][j] = a[i][j] + b[i][j];
            }
        }
    }

    end = omp_get_wtime();

    exec = end - start;
```

```
    printf("%d, %f\n", thread, exec);

    return 0;
}
```

Threads vs Time



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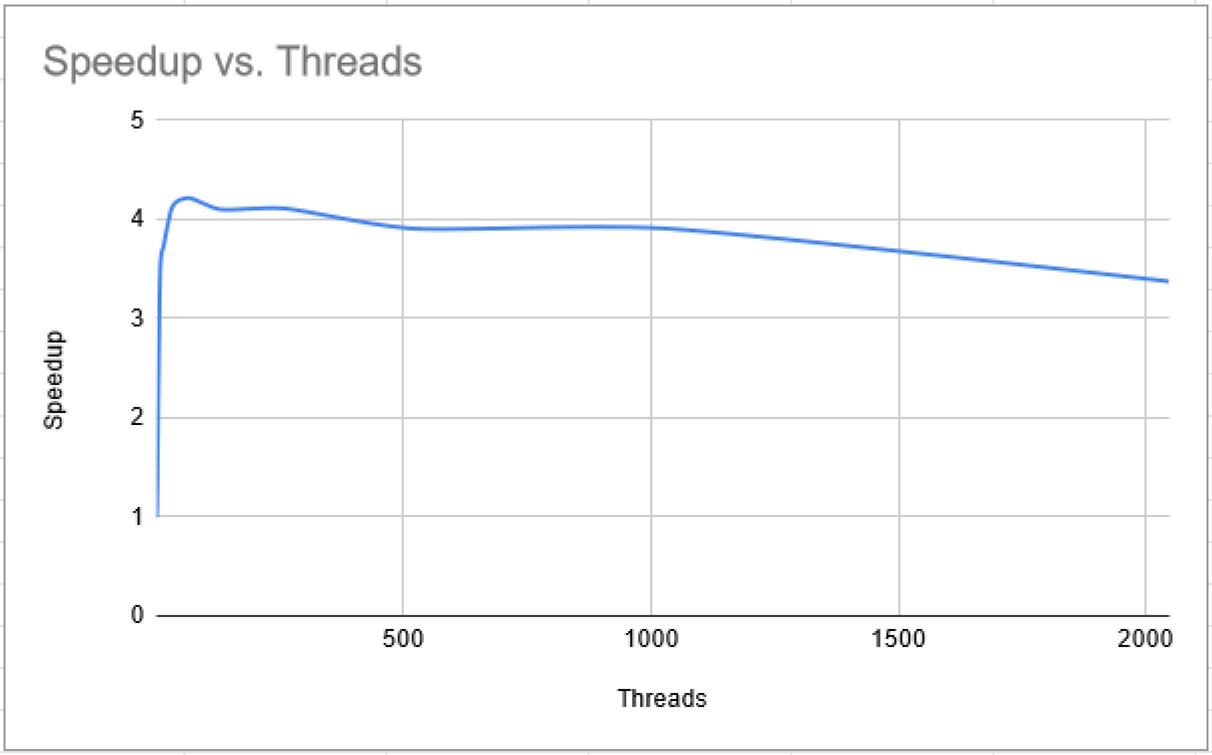
Speedups vs Threads



Parallelization factor

Formula for calculating the Parallelization Factor = (1-(1/speedup))*(1-(1/p))
where, p = number of threads/processor

Threads	Exec Time	Speedup	Parallelization Factor
1	2.023309	1	0
2	1.678896	1.205142546	0.1418522002
4	0.967484	2.091310037	0.3478872151
8	0.584612	3.460943327	0.2370204782
16	0.539576	3.749812816	-0.2444400073
32	0.491076	4.120154518	-1.262151093
64	0.479891	4.216184509	-3.305547826
128	0.49336	4.101080347	-7.309564184
256	0.492139	4.111255154	-15.38756067
512	0.517559	3.909330144	-31.00840422
1024	0.517592	3.909080898	-62.75963467
2048	0.599944	3.372496433	-119.3577427

Inferences

From the above graphs and data we can clearly observe that the execution time decreases until a particular point and then increases as we add more threads to run the process.Using many threads leads to more context switches which lowers the speed up. We can conclude that the maximum parallelization happens at 64 threads