Practical No 8

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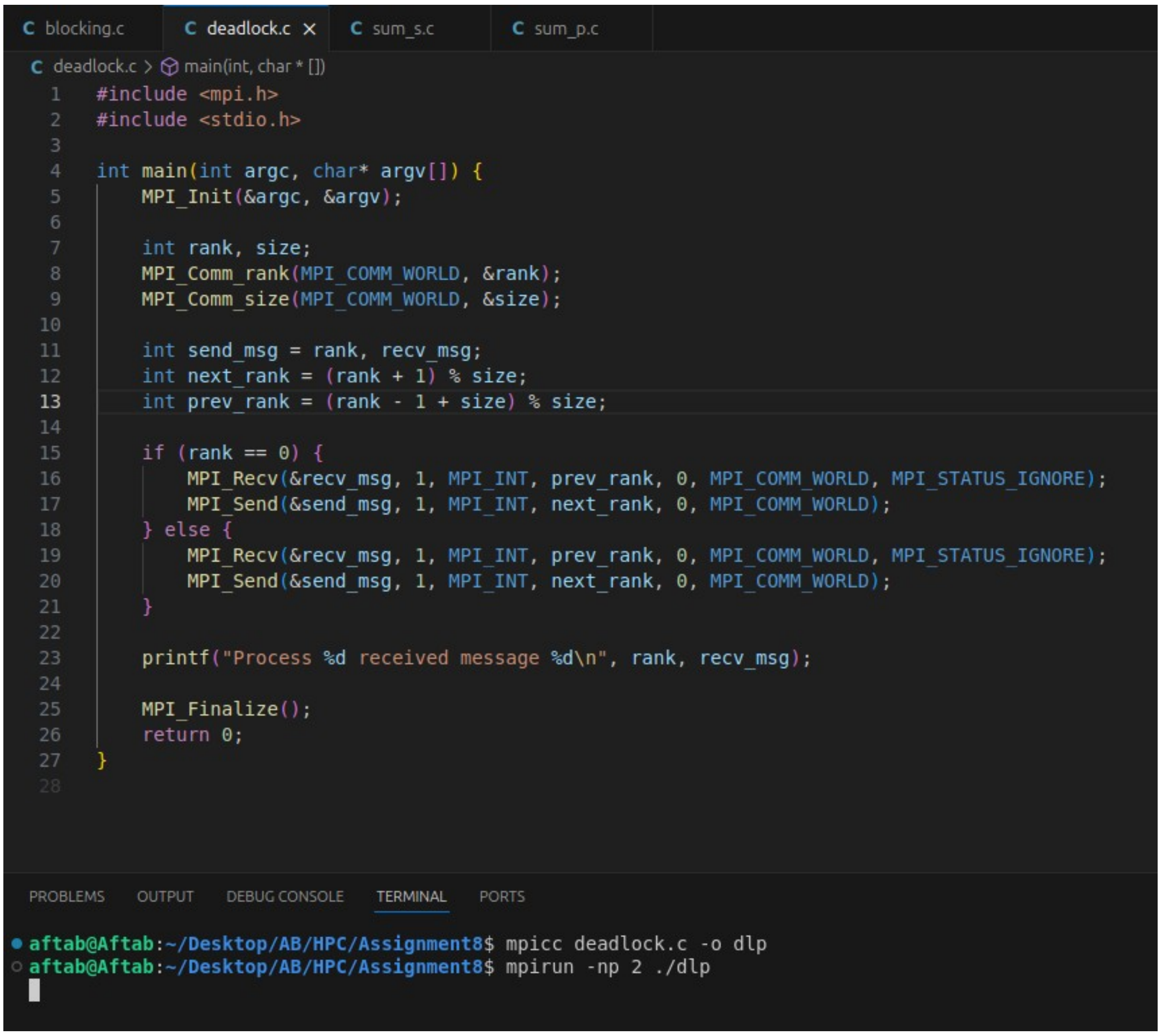
Batch: B6

Course: High Performance Computing Lab

Title of practical:

Q1: Implement a MPI program to give an example of Deadlock.

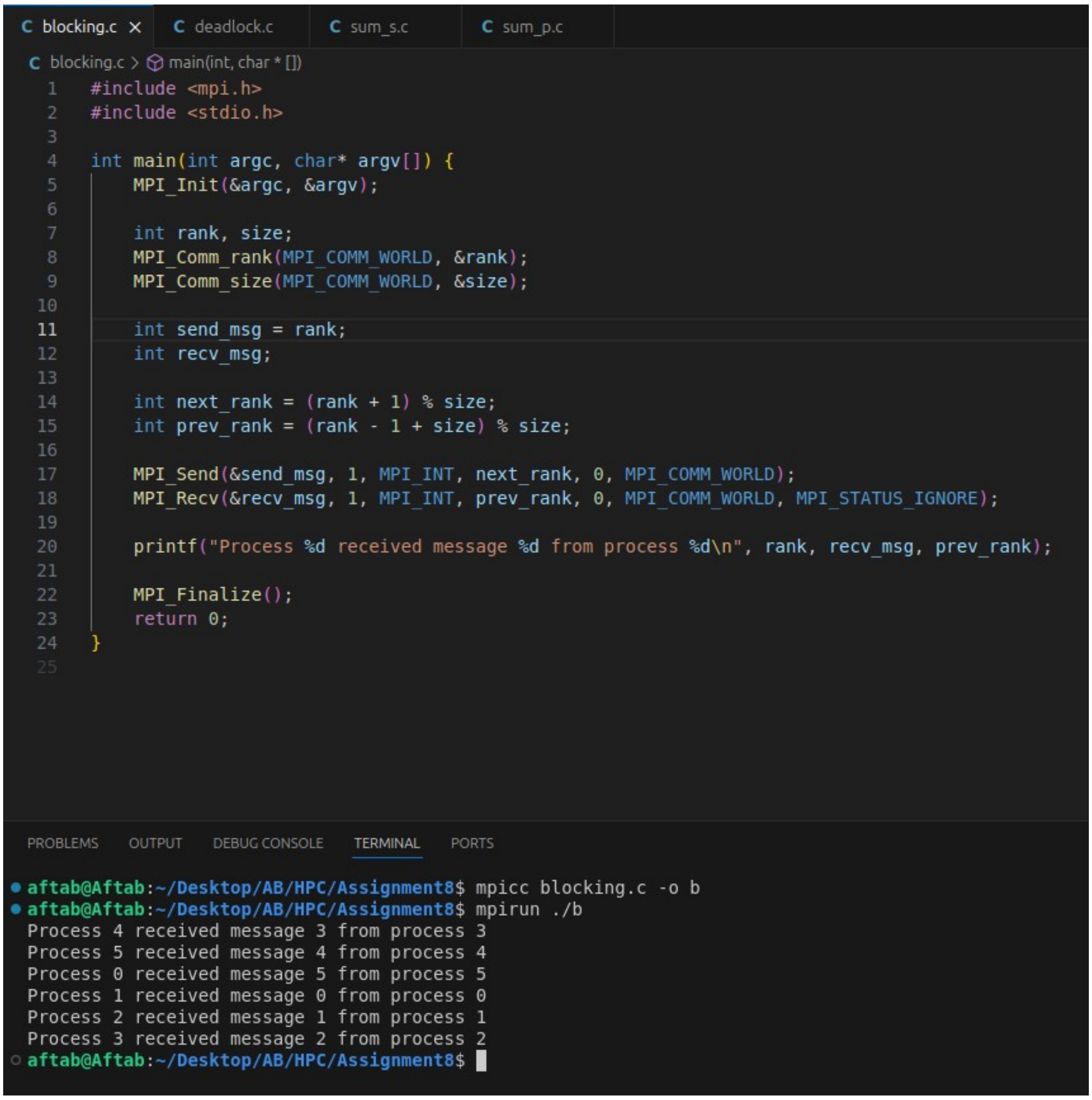
Screenshot:



```c
#include <mpi.h>
#include <stdio.h>

int main(int argc, char* argv[]) {
    MPI_Init(&argc, &argv);

    int rank, size;
    MPI_Comm_rank(MPI_COMM_WORLD, &rank);
    MPI_Comm_size(MPI_COMM_WORLD, &size);

    int send_msg = rank, recv_msg;
    int next_rank = (rank + 1) % size;
    int prev_rank = (rank - 1 + size) % size;

    if (rank == 0) {
        MPI_Recv(&recv_msg, 1, MPI_INT, prev_rank, 0, MPI_COMM_WORLD, MPI_STATUS_IGNORE);
        MPI_Send(&send_msg, 1, MPI_INT, next_rank, 0, MPI_COMM_WORLD);
    } else {
        MPI_Recv(&recv_msg, 1, MPI_INT, prev_rank, 0, MPI_COMM_WORLD, MPI_STATUS_IGNORE);
        MPI_Send(&send_msg, 1, MPI_INT, next_rank, 0, MPI_COMM_WORLD);
    }

    printf("Process %d received message %d\n", rank, recv_msg);

    MPI_Finalize();
    return 0;
}
```

```
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$ mpicc deadlock.c -o dlp
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$ mpirun -np 2 ./dlp
```

Q2. Implement blocking MPI send & receive to demonstrate Nearest neighbor exchange of data in a ring topology.



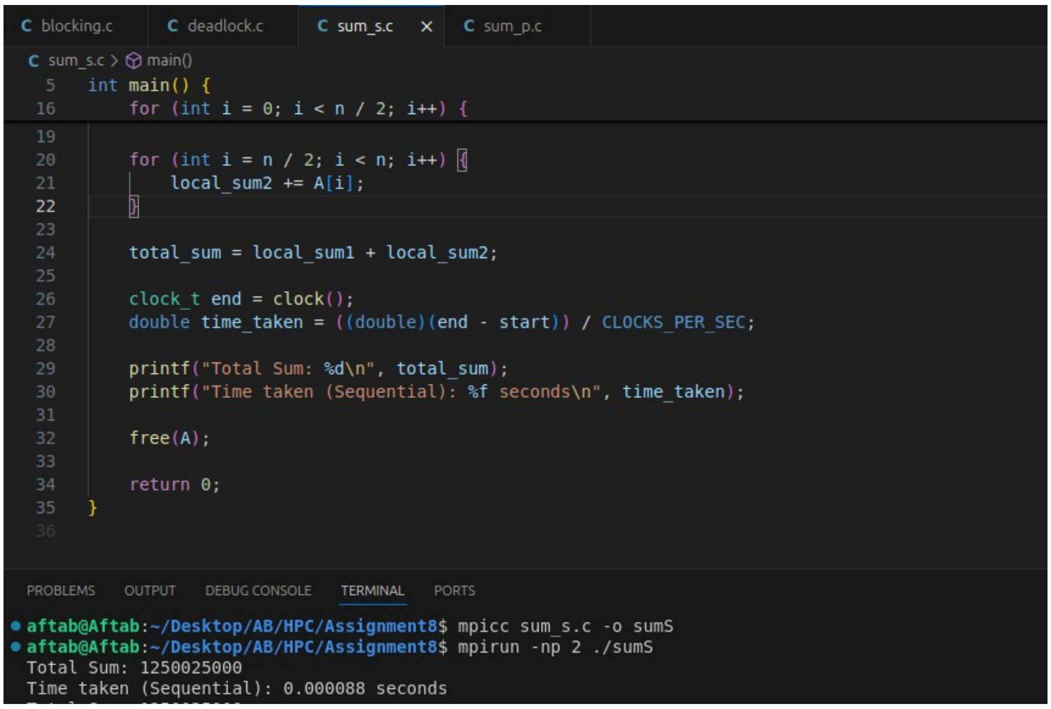
```c
#include <mpi.h>
#include <stdio.h>

int main(int argc, char* argv[]) {
    MPI_Init(&argc, &argv);

    int rank, size;
    MPI_Comm_rank(MPI_COMM_WORLD, &rank);
    MPI_Comm_size(MPI_COMM_WORLD, &size);

    int send_msg = rank;
    int recv_msg;

    int next_rank = (rank + 1) % size;
    int prev_rank = (rank - 1 + size) % size;

    MPI_Send(&send_msg, 1, MPI_INT, next_rank, 0, MPI_COMM_WORLD);
    MPI_Recv(&recv_msg, 1, MPI_INT, prev_rank, 0, MPI_COMM_WORLD, MPI_STATUS_IGNORE);

    printf("Process %d received message %d from process %d\n", rank, recv_msg, prev_rank);

    MPI_Finalize();
    return 0;
}
```

```
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$ mpicc blocking.c -o b
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$ mpirun ./b
Process 4 received message 3 from process 3
Process 5 received message 4 from process 4
Process 0 received message 5 from process 5
Process 1 received message 0 from process 0
Process 2 received message 1 from process 1
Process 3 received message 2 from process 2
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$
```

Q3. Write a MPI program to find the sum of all the elements of an array A of size n. Elements of an array can be divided into two equals groups. The first [n/2] elements are added by the first process, P0, and last [n/2] elements the by second process, P1. The two sums then are added to get the final result.

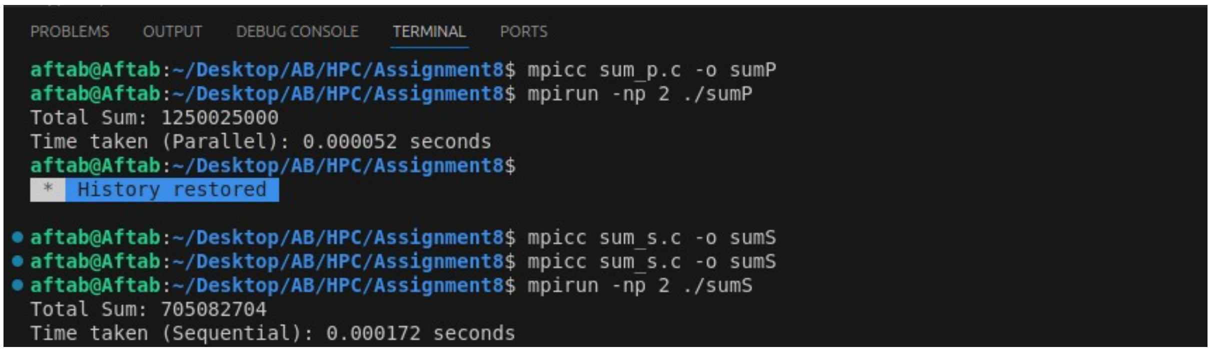
a) Sequential Code:

```
#include <stdio.h>

#include <stdlib.h>

#include <time.h>

int main() {

int n = 50000;

int *A = (int*) malloc(n * sizeof(int));

int local_sum1 = 0, local_sum2 = 0, total_sum = 0;

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

A[i] = i + 1;

}

clock_t start = clock();

for (int i = 0; i < n / 2; i++) {

local_sum1 += A[i];

}

for (int i = n / 2; i < n; i++) {

local_sum2 += A[i];

}

total_sum = local_sum1 + local_sum2;

clock_t end = clock();

double time_taken = ((double)(end - start)) / CLOCKS_PER_SEC;

printf("Total Sum: %d\n", total_sum);

printf("Time taken (Sequential): %f seconds\n", time_taken);

free(A);

return 0;

}
```



```
int main() {
    for (int i = 0; i < n / 2; i++) {

    for (int i = n / 2; i < n; i++) {
        local_sum2 += A[i];
    }

    total_sum = local_sum1 + local_sum2;

    clock_t end = clock();
    double time_taken = ((double)(end - start)) / CLOCKS_PER_SEC;

    printf("Total Sum: %d\n", total_sum);
    printf("Time taken (Sequential): %f seconds\n", time_taken);

    free(A);

    return 0;
}
```

```
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$ mpicc sum_s.c -o sumS
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$ mpirun -np 2 ./sumS
Total Sum: 1250025000
Time taken (Sequential): 0.000088 seconds
```



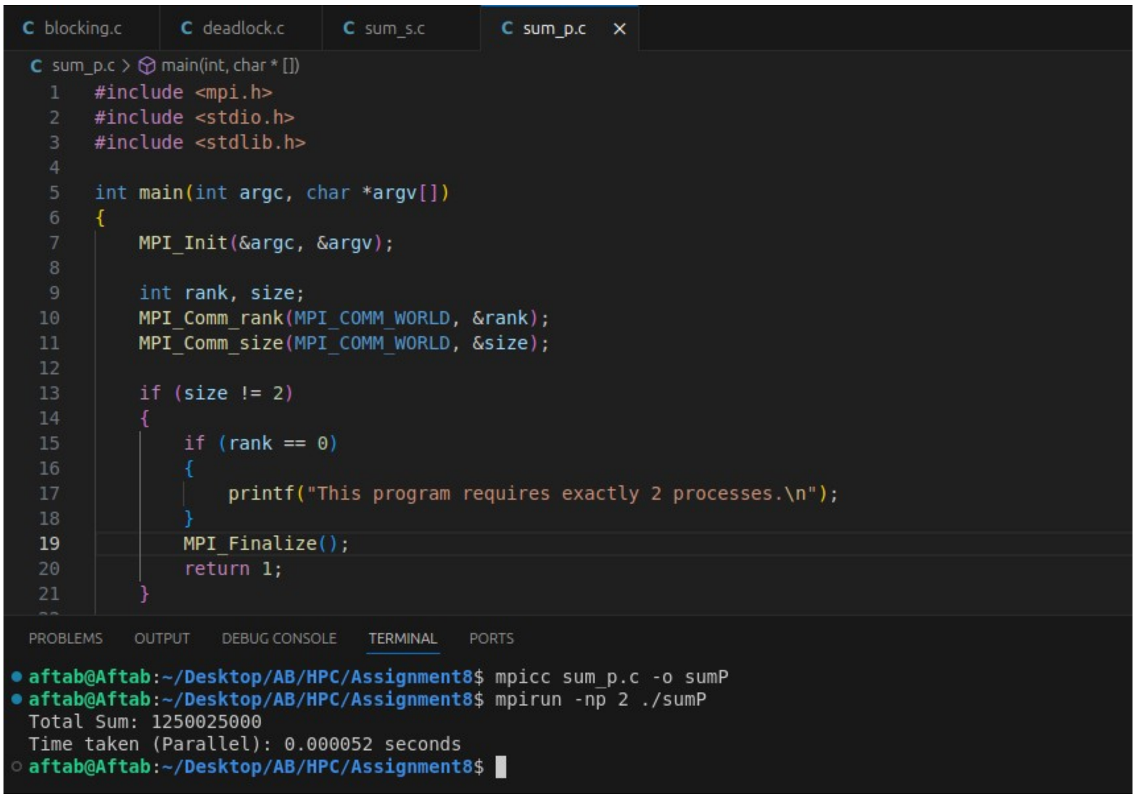
```
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$ mpicc sum_p.c -o sumP
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$ mpirun -np 2 ./sumP
Total Sum: 1250025000
Time taken (Parallel): 0.000052 seconds
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$
 *  History restored

aftab@Aftab:~/Desktop/AB/HPC/Assignment8$ mpicc sum_s.c -o sumS
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$ mpicc sum_s.c -o sumS
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$ mpirun -np 2 ./sumS
Total Sum: 705082704
Time taken (Sequential): 0.000172 seconds
```

a) Parallel Code

```
#include <mpi.h>

#include <stdio.h>

#include <stdlib.h>


int main(int argc, char *argv[])

{

MPI_Init(&argc, &argv);
```

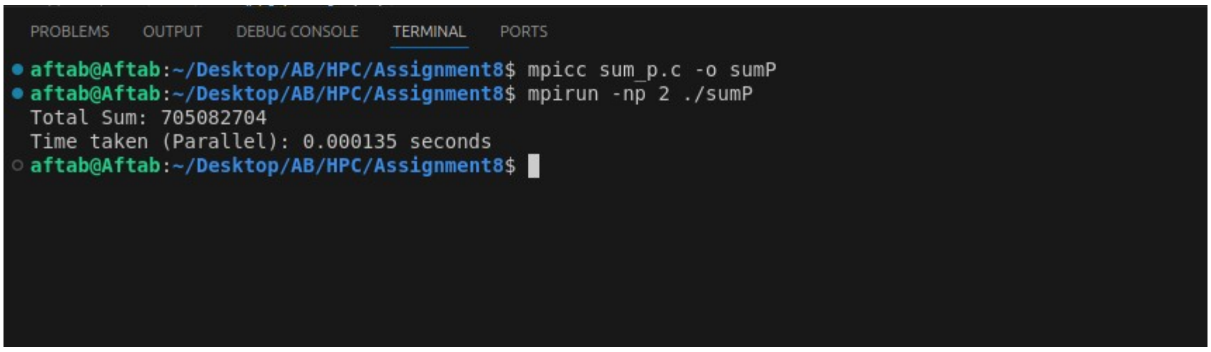
```
int rank, size;
MPI_Comm_rank(MPI_COMM_WORLD, &rank);
MPI_Comm_size(MPI_COMM_WORLD, &size);

if (size != 2)
{
if (rank == 0)
{
printf("This program requires exactly 2 processes.\n");
}
MPI_Finalize();
return 1;
}

int n = 50000;
int *A = (int *)malloc(n * sizeof(int));
int local_sum = 0, total_sum = 0;

if (rank == 0)
{
for (int i = 0; i < n; i++)
{
A[i] = i + 1;
}
}

MPI_Bcast(A, n, MPI_INT, 0, MPI_COMM_WORLD);

double start_time = MPI_Wtime();
```

```
if (rank == 0)
{
for (int i = 0; i < n / 2; i++)
{
local_sum += A[i];
}
}
else if (rank == 1)
{
for (int i = n / 2; i < n; i++)
{
local_sum += A[i];
}
}

MPI_Reduce(&local_sum, &total_sum, 1, MPI_INT, MPI_SUM, 0,
MPI_COMM_WORLD);
double end_time = MPI_Wtime();
double time_taken = end_time - start_time;
if (rank == 0)
{
printf("Total Sum: %d\n", total_sum);
printf("Time taken (Parallel): %f seconds\n", time_taken);
}
free(A);
MPI_Finalize();
return 0;
}
```



```
#include <mpi.h>
#include <stdio.h>
#include <stdlib.h>

int main(int argc, char *argv[])
{
    MPI_Init(&argc, &argv);

    int rank, size;
    MPI_Comm_rank(MPI_COMM_WORLD, &rank);
    MPI_Comm_size(MPI_COMM_WORLD, &size);

    if (size != 2)
    {
        if (rank == 0)
        {
            printf("This program requires exactly 2 processes.\n");
        }
        MPI_Finalize();
        return 1;
    }
```

```
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$ mpicc sum_p.c -o sumP
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$ mpirun -np 2 ./sumP
Total Sum: 1250025000
Time taken (Parallel): 0.000052 seconds
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$
```



```
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$ mpicc sum_p.c -o sumP
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$ mpirun -np 2 ./sumP
Total Sum: 705082704
Time taken (Parallel): 0.000135 seconds
aftab@Aftab:~/Desktop/AB/HPC/Assignment8$
```

Analysis:

Input Size (n)	Parallel	Sequential
50000	0.000052	0.000088
100000	0.000135	0.000172