Final Year B. Tech., Sem VII 2022-23

High Performance Computing Lab

PRN: 2020BTECS00206

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Batch: B4

Assignment No. 6

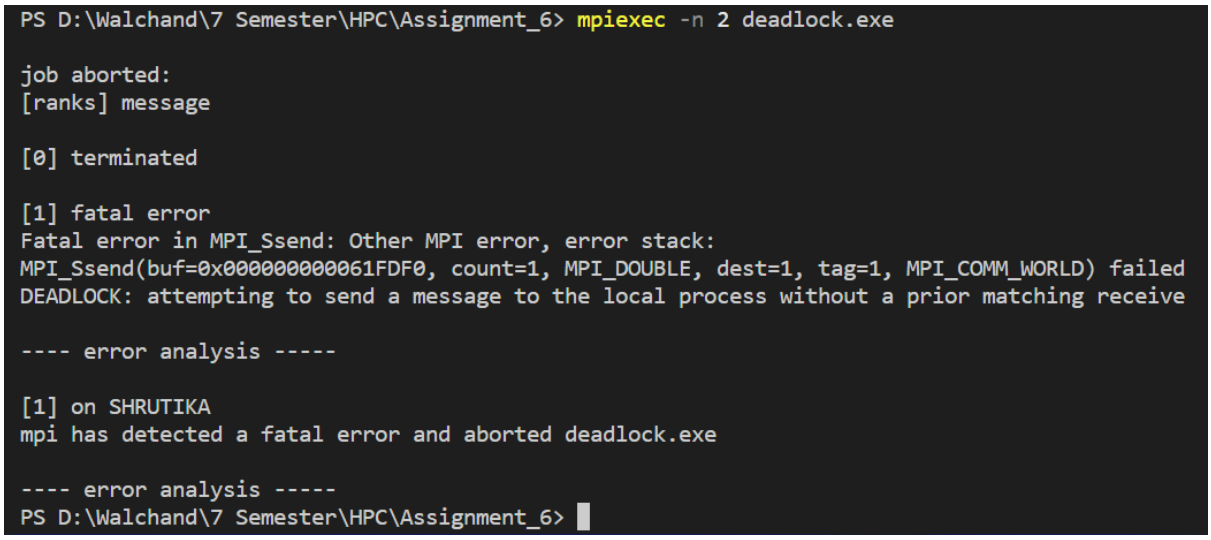
Q1: Implement a MPI program to give an example of Deadlock.

- **Code:**

```
#include "mpi.h"
#include <math.h>
int main(int argc, char **argv) {
MPI_Status status;
int num;
MPI_Init(&argc, &argv);
MPI_Comm_rank(MPI_COMM_WORLD, &num);
double d = 100.0;
int tag = 1;
if (num == 0) {
// synchronous Send
MPI_Ssend(&d, 1, MPI_DOUBLE, 1, tag,
MPI_COMM_WORLD);
MPI_Recv(&d, 1, MPI_DOUBLE, 1, tag,
MPI_COMM_WORLD, &status);
```

```
} else {

// Synchronous Send

MPI_Ssend(&d, 1, MPI_DOUBLE, 1, tag,

MPI_COMM_WORLD);

MPI_Recv(&d, 1, MPI_DOUBLE, 1, tag,

MPI_COMM_WORLD, &status);

}

MPI_Finalize();

return 0;

}
```

- **Output:**



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

- **Code:**

```
#include "mpi.h"

#include <stdio.h>

int main(int argc, char **argv) {

int rank;

int num;

MPI_Init(&argc, &argv);

MPI_Comm_size(MPI_COMM_WORLD, &num);

MPI_Comm_rank(MPI_COMM_WORLD, &rank);

MPI_Status status;

double d = 483048.0;

int tag = 1;

// calculating next rank

int rank_next = (rank + 1) % num;

// prev process rank

int rank_prev = rank == 0 ? num - 1 : rank - 1;

if (num % 2 == 0) {

printf("Rank %d: sending to %d\n", rank,

rank_next);

MPI_Send(&d, 1, MPI_DOUBLE, rank_next, tag,

MPI_COMM_WORLD);

printf("Rank %d: receiving from %d\n", rank,
```

```
rank_prev);
MPI_Recv(&d, 1, MPI_DOUBLE, rank_prev, tag,
MPI_COMM_WORLD, &status);
} else {
printf("Rank %d: receiving from %d\n", rank,
rank_prev);
MPI_Recv(&d, 1, MPI_DOUBLE, rank_prev, tag,
MPI_COMM_WORLD, &status);
printf("Rank %d: sending to %d\n", rank,
rank_next);
MPI_Send(&d, 1, MPI_DOUBLE, rank_next, tag,
MPI_COMM_WORLD);
}
MPI_Finalize();
return 0;
}
```

- **Output:**

```
PS D:\Walchand\7 Semester\HPC\Assignment_6> mpiexec -n 2 que1_blocking.exe
Rank 1: sending to 0
Rank 1: receiving from 0
Rank 0: sending to 1
Rank 0: receiving from 1
PS D:\Walchand\7 Semester\HPC\Assignment_6> mpiexec -n 4 que1_blocking.exe
Rank 0: sending to 1
Rank 0: receiving from 3
Rank 1: sending to 2
Rank 1: receiving from 0
Rank 3: sending to 0
Rank 3: receiving from 2
Rank 2: sending to 3
Rank 2: receiving from 1
PS D:\Walchand\7 Semester\HPC\Assignment_6>
```

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.

- **Code:**

```
#include "mpi.h"

#include <stdio.h>


#define localSize 1000


int local[1000]; // to store the subarray data comming from process 0;


int main(int argc, char **argv)

{

   int rank;

   int num;


   int n = 10;

   int arr[10] = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10};


   int per_process, elements_received;


   MPI_Init(&argc, &argv);


   MPI_Comm_size(MPI_COMM_WORLD, &num);

   MPI_Comm_rank(MPI_COMM_WORLD, &rank);
```

```
    MPI_Status status;


    // process with rank 0 will divide data among all processes and add partial sums to get final
sum
    if (rank == 0)
    {
        int index, i;


        per_process = n / num;


        if (num > 1) // if more than 1 processes available
        {
            // divide array data among processes
            for (i = 1; i < num - 1; i++)
            {
                // calculating first index of subarray that need to be send to ith process
                index = i * per_process;


                // send no of elements and subarray of that lenght to each process
                MPI_Send(&per_process, 1, MPI_INT, i, 0, MPI_COMM_WORLD);
                MPI_Send(&arr[index], per_process, MPI_INT, i, 0, MPI_COMM_WORLD);
            }
```

```
        // for last process send all remaining elements
        index = i * per_process;
        int ele_left = n - index;

        MPI_Send(&ele_left, 1, MPI_INT, i, 0, MPI_COMM_WORLD);
        MPI_Send(&arr[index], ele_left, MPI_INT, i, 0, MPI_COMM_WORLD);
    }

    // add numbers on process with rank 0
    int sum = 0;
    for (int i = 0; i < per_process; i++)
    {
        sum += arr[i];
    }

    // add all partial sums from all processes
    int tmp;
    for (int i = 1; i < num; i++)
    {
        MPI_Recv(&tmp, 1, MPI_INT, MPI_ANY_SOURCE, 0, MPI_COMM_WORLD,
&status);

        int sender = status.MPI_SOURCE;
```

```
            sum += tmp;
        }

        printf("Sum of array = %d\n", sum);
    }
    else // if rank of process is not 0, then receive elements and calculate partial sums
    {
        // receive no of elements and elements form process 0 and store them on local array
        MPI_Recv(&elements_received, 1, MPI_INT, 0, 0, MPI_COMM_WORLD, &status);

        MPI_Recv(&local, elements_received, MPI_INT, 0, 0, MPI_COMM_WORLD, &status);

        // calculate partial local sum
        int partial_sum = 0;
        for (int i = 0; i < elements_received; i++)
        {
            partial_sum += local[i];
        }

        // send calculated partial sum to process with rank 0
        MPI_Send(&partial_sum, 1, MPI_INT, 0, 0, MPI_COMM_WORLD);
    }
```

```
    MPI_Finalize();

    return 0;

}
```

- **Output:**

```
PS D:\Walchand\7 Semester\HPC\Assignment_6> mpiexec -n 2 .\array_sum.exe
Sum of array = 55
PS D:\Walchand\7 Semester\HPC\Assignment_6> mpiexec -n 2 .\array_sum.exe
Sum of array = 55
```

Github Link: https://github.com/SayaliDesai4/HPC-Practicals
