SALIH KILICLI – STAT 624 HOMEWORK 7

—— SETUP ——

```
dos2unix HW7.job                    # Otherwise it gives error about line breakers
sbatch HW7.job
sacct
sacct -X -j job_id
```

I have edited the given C file "prime.c" and renamed it to "prime_mpi.c". Also, I have written a batch file HW7.job in order to submit a job to the Terra. The edited C file and the bash file and their outputs of running specific commands are given below. The parts that I have edited in C file is colored by green.

—— PRIME_MPI.C file ——

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

int isprime(int n) {
  int i, sq;
  sq = (int) sqrt(n);
  for (i=3; i<=sq; i+=2)
    if ((n%i) == 0) return 0;
  return 1;
}

int main(int argc, char *argv[])
{
  int i, p=0, max;
  //max=100000000;  // 100 million (primes=5761455)
 max=2100000000;    // 2.1 billion (primes=102886526)
  int ntasks, rank, size, length, start, h, psum;
  double start_time, end_time, wct;
  char node[MPI_MAX_PROCESSOR_NAME];
   MPI_Init(&argc, &argv);    // Initialize MPI
  MPI_Comm_rank(MPI_COMM_WORLD, &rank);   // Rank (task ID)
  MPI_Comm_size(MPI_COMM_WORLD, &ntasks); // Number of tasks
```

```
 MPI_Get_processor_name(node, &length);   // MPI name
 start_time = MPI_Wtime();   // initialize the timer
 start = (rank*2)+1;              // Finds the starting point (odd number)
 h = ntasks*2;                    // step size (stride)

 MPI_Bcast(&max,1,MPI_INT,0,MPI_COMM_WORLD);  //broadcasting max variable to all ranks

 if (rank==0){
 printf("Numbers to be scanned = %d\n", max);
   for (i=start; i<=max; i+=h){
     if (isprime(i)) p++;
   }
   MPI_Reduce(&p,&psum,1,MPI_INT,MPI_SUM,0,MPI_COMM_WORLD);
   printf("Rank = %d/64 , Node = %s , Primes found = %d\n", rank, node, p);
 }

 if(rank>0){
   for (i=start; i<=max; i+=h) {
     if (isprime(i)) p++;
   }
   printf("Rank = %d/64 , Node = %s , Primes found = %d\n", rank, node, p);
   MPI_Reduce(&p,&psum,1,MPI_INT,MPI_SUM,0,MPI_COMM_WORLD);
 }

 MPI_Barrier(MPI_COMM_WORLD);   // Blocks until all processes reaches this routine

if(rank==0){
   printf("Total primes = %d\n", psum);
   end_time = MPI_Wtime();
   wct=end_time-start_time;
   printf("Wallclock time elapsed: %.2lf seconds\n", wct);
 }

 MPI_Finalize();                          // Finalize MPI
}
```

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A screenshot of running prime_mpi file (with max=100,000,000 and 8 nodes) on terra is given below.

```
[math3mantic@terra3 hw7]$ ls
HW7.job  prime  prime.c  prime_mpi  prime_mpi.c
[math3mantic@terra3 hw7]$ module load intel/2019b
[math3mantic@terra3 hw7]$ mpiicc -O2 -xHost -o prime_mpi prime_mpi.c -lm
[math3mantic@terra3 hw7]$ mpirun -np 8 ./prime_mpi
Numbers to be scanned = 100000000
Rank = 5/8 , Node = tlogin-0301 , Primes found = 720077
Rank = 7/8 , Node = tlogin-0301 , Primes found = 719950
Rank = 6/8 , Node = tlogin-0301 , Primes found = 720259
Rank = 4/8 , Node = tlogin-0301 , Primes found = 719964
Rank = 2/8 , Node = tlogin-0301 , Primes found = 720275
Rank = 3/8 , Node = tlogin-0301 , Primes found = 720456
Rank = 1/8 , Node = tlogin-0301 , Primes found = 720467
Rank = 0/8 , Node = tlogin-0301 , Primes found = 720007
Total primes = 5761455
Wallclock time elapsed: 8.23 seconds
```

—— HW7.job file ——

```
#!/bin/bash

## ENVIRONMENT SETTINGS

#SBATCH --export=NONE                # Do not propagate environment

#SBATCH --get-user-env=L             # Replicate login environment

##NECESSARY JOB SPECIFICATIONS

#SBATCH --job-name=HW7               # Change job name to HW7

#SBATCH --time=00:05:00              # Set the wall clock limit to 5 min

#SBATCH --nodes=8                    # Request 8 nodes

#SBATCH --ntasks-per-node=8          # Request 8 cores for each node (64 nodes)

#SBATCH --mem=2000M                  # Request 2000 MB per node

#SBATCH --partition=medium           # Request medium queue

#SBATCH --output=stdout.%j           # Send stdout and stderr to :stdout.[jobid]"
```

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```
# Load required modules

echo "loading module: intel/2019b"

module load intel/2019b

# Run your program

echo "..... Running prime_mpi.c File ....."

mpirun ./prime_mpi

# User Options for Terra

# sacct -X -j job_id  - Shows information the job with given id
```

—— FINAL REMARKS ——

Problem 1: Image below is the output obtained from running job file and viewing account info on Terra.

```
[math3mantic@terra3 hw7]$ ls
HW7.job  prime  prime.c  prime_mpi  prime_mpi.c
[math3mantic@terra3 hw7]$ mpiicc -O2 -xHost -o prime_mpi prime_mpi.c -lm
[math3mantic@terra3 hw7]$ dos2unix HW7.job
dos2unix: converting file HW7.job to Unix format ...
[math3mantic@terra3 hw7]$ sbatch HW7.job
Submitted batch job 3301451
(from job_submit) your job is charged as below
             Project Account: 122753717080
             Account Balance: 4986.972778
             Requested SUs:   5.3333333333333
[math3mantic@terra3 hw7]$ sacct -X -j 3301451
     JobID             JobName                User      NCPUS   NNodes      State      Elapsed      CPUTime               Start                 End   ReqMem
     NodeList
---------- -------------------- ---------------------- ---------- -------- ---------- ------------ ------------ -------------------- -------------------- --------
-------------
   3301451                HW7             math3mantic         64        8    RUNNING     00:00:07     00:07:28  2019-10-31T11:41:10              Unknown   2000Mn
16,0619-0620]
[math3mantic@terra3 hw7]$ sacct -X -j 3301451
     JobID             JobName                User      NCPUS   NNodes      State      Elapsed      CPUTime               Start                 End   ReqMem
     NodeList
---------- -------------------- ---------------------- ---------- -------- ---------- ------------ ------------ -------------------- -------------------- --------
-------------
   3301451                HW7             math3mantic         64        8    RUNNING     00:00:35     00:37:20  2019-10-31T11:41:10              Unknown   2000Mn
16,0619-0620]
[math3mantic@terra3 hw7]$ sacct -X -j 3301451
     JobID             JobName                User      NCPUS   NNodes      State      Elapsed      CPUTime               Start                 End   ReqMem
     NodeList
---------- -------------------- ---------------------- ---------- -------- ---------- ------------ ------------ -------------------- -------------------- --------
-------------
   3301451                HW7             math3mantic         64        8    RUNNING     00:01:21     01:26:24  2019-10-31T11:41:10              Unknown   2000Mn
16,0619-0620]
[math3mantic@terra3 hw7]$ sacct -X -j 3301451
     JobID             JobName                User      NCPUS   NNodes      State      Elapsed      CPUTime               Start                 End   ReqMem
     NodeList
---------- -------------------- ---------------------- ---------- -------- ---------- ------------ ------------ -------------------- -------------------- --------
-------------
   3301451                HW7             math3mantic         64        8  COMPLETED     00:01:26     01:31:44  2019-10-31T11:41:10  2019-10-31T11:42:36   2000Mn
16,0619-0620]
[math3mantic@terra3 hw7]$ ls
HW7.job  prime  prime.c  prime_mpi  prime_mpi.c  stdout.3301451
```

Image below is the output that is obtained from running the job on Terra (output from stdout.3301451).

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```
[math3mantic@terra3 hw7]$ ls
HW7.job  prime  prime.c  prime_mpi  prime_mpi.c  stdout.3301451
[math3mantic@terra3 hw7]$ cat stdout.3301451
loading module: intel/2019
 ..... Running prime_mpi C File .....
Numbers to be scanned = 2100000000
Rank = 5/64 , Node = tnxt-0602.cluster , Primes found = 1607300
Rank = 6/64 , Node = tnxt-0602.cluster , Primes found = 1607543
Rank = 2/64 , Node = tnxt-0602.cluster , Primes found = 1607298
Rank = 4/64 , Node = tnxt-0602.cluster , Primes found = 1607669
Rank = 3/64 , Node = tnxt-0602.cluster , Primes found = 1607987
Rank = 1/64 , Node = tnxt-0602.cluster , Primes found = 1607936
Rank = 7/64 , Node = tnxt-0602.cluster , Primes found = 1608495
Rank = 36/64 , Node = tnxt-0614.cluster , Primes found = 1606720
Rank = 19/64 , Node = tnxt-0610.cluster , Primes found = 1607470
Rank = 54/64 , Node = tnxt-0619.cluster , Primes found = 1607476
Rank = 16/64 , Node = tnxt-0610.cluster , Primes found = 1607063
Rank = 10/64 , Node = tnxt-0609.cluster , Primes found = 1606608
Rank = 20/64 , Node = tnxt-0610.cluster , Primes found = 1607258
Rank = 25/64 , Node = tnxt-0612.cluster , Primes found = 1608097
Rank = 51/64 , Node = tnxt-0619.cluster , Primes found = 1607986
Rank = 24/64 , Node = tnxt-0612.cluster , Primes found = 1607610
Rank = 26/64 , Node = tnxt-0612.cluster , Primes found = 1607261
Rank = 53/64 , Node = tnxt-0619.cluster , Primes found = 1608101
Rank = 17/64 , Node = tnxt-0610.cluster , Primes found = 1607730
Rank = 34/64 , Node = tnxt-0614.cluster , Primes found = 1608151
Rank = 57/64 , Node = tnxt-0620.cluster , Primes found = 1606927
Rank = 30/64 , Node = tnxt-0612.cluster , Primes found = 1607952
Rank = 33/64 , Node = tnxt-0614.cluster , Primes found = 1608062
Rank = 11/64 , Node = tnxt-0609.cluster , Primes found = 1607647
Rank = 31/64 , Node = tnxt-0612.cluster , Primes found = 1608103
Rank = 9/64 , Node = tnxt-0609.cluster , Primes found = 1607708
Rank = 14/64 , Node = tnxt-0609.cluster , Primes found = 1607449
Rank = 28/64 , Node = tnxt-0612.cluster , Primes found = 1607746
Rank = 22/64 , Node = tnxt-0610.cluster , Primes found = 1607928
Rank = 45/64 , Node = tnxt-0616.cluster , Primes found = 1607241
Rank = 47/64 , Node = tnxt-0616.cluster , Primes found = 1606876
Rank = 35/64 , Node = tnxt-0614.cluster , Primes found = 1607297
Rank = 60/64 , Node = tnxt-0620.cluster , Primes found = 1607703
Rank = 43/64 , Node = tnxt-0616.cluster , Primes found = 1607838
Rank = 8/64 , Node = tnxt-0609.cluster , Primes found = 1607525
Rank = 59/64 , Node = tnxt-0620.cluster , Primes found = 1607450
Rank = 40/64 , Node = tnxt-0616.cluster , Primes found = 1608084
Rank = 13/64 , Node = tnxt-0609.cluster , Primes found = 1607426
Rank = 62/64 , Node = tnxt-0620.cluster , Primes found = 1607446
Rank = 48/64 , Node = tnxt-0619.cluster , Primes found = 1607379
Rank = 37/64 , Node = tnxt-0614.cluster , Primes found = 1607299
Rank = 27/64 , Node = tnxt-0612.cluster , Primes found = 1607537
Rank = 49/64 , Node = tnxt-0619.cluster , Primes found = 1607586
Rank = 21/64 , Node = tnxt-0610.cluster , Primes found = 1607652
Rank = 15/64 , Node = tnxt-0609.cluster , Primes found = 1607959
Rank = 38/64 , Node = tnxt-0614.cluster , Primes found = 1607870
Rank = 41/64 , Node = tnxt-0616.cluster , Primes found = 1607005
Rank = 55/64 , Node = tnxt-0619.cluster , Primes found = 1606983
Rank = 52/64 , Node = tnxt-0619.cluster , Primes found = 1608119
Rank = 50/64 , Node = tnxt-0619.cluster , Primes found = 1607946
Rank = 29/64 , Node = tnxt-0612.cluster , Primes found = 1607199
Rank = 32/64 , Node = tnxt-0614.cluster , Primes found = 1607770
Rank = 56/64 , Node = tnxt-0620.cluster , Primes found = 1606833
Rank = 23/64 , Node = tnxt-0610.cluster , Primes found = 1607898
Rank = 42/64 , Node = tnxt-0616.cluster , Primes found = 1608064
Rank = 44/64 , Node = tnxt-0616.cluster , Primes found = 1607115
Rank = 39/64 , Node = tnxt-0614.cluster , Primes found = 1607548
Rank = 18/64 , Node = tnxt-0610.cluster , Primes found = 1608197
Rank = 58/64 , Node = tnxt-0620.cluster , Primes found = 1607849
Rank = 61/64 , Node = tnxt-0620.cluster , Primes found = 1607963
Rank = 63/64 , Node = tnxt-0620.cluster , Primes found = 1607863
Rank = 46/64 , Node = tnxt-0616.cluster , Primes found = 1607727
Rank = 12/64 , Node = tnxt-0609.cluster , Primes found = 1607594
Rank = 0/64 , Node = tnxt-0602.cluster , Primes found = 1607404
Total primes = 102886526
Wallclock time elapsed: 80.45 seconds
[math3mantic@terra3 hw7]$
```