CSCE 689-600 Spring 2020

HW 1: Parallel Programming with MPI

Due: 11:59pm Wednesday, January 29, 2020

Compile and execute the program in the file `compute_pi_mpi.c`, which computes an estimate of π using the parallel algorithm discussed in class. The program is available on the shared Google Drive for this class. It should be compiled and executed on either `ada.tamu.edu` or `terra.tamu.edu`.

Load the Intel software stack prior to compiling and executing the code.

```
module load intel/2017A
```

To compile, use the command:

```
mpiicc -o compute_pi_mpi.exe compute_pi_mpi.c
```

To execute the program, use

```
mpirun –np <p> ./compute_pi_mpi.exe <n>
```

where <n> represents the number of intervals and <p> represents the number of processes. The output of a sample run is shown below.

```
mpirun -np 4 compute_pi_mpi.exe 100000000
n = 100000000, p = 4, pi = 3.1415926535897749, relative error =
5.80e-15, time (sec) =   0.0608
```

The run time of the code should be measured when it is executed in dedicated mode. Use the batch file `compute_pi_mpi.job`, to execute the code in dedicated mode using the following command on ADA:

```
bsub < compute_pi_mpi.job
```

On Terra, you will need to use `compute_pi.terra_job`, and the corresponding command is:

```
sbatch compute_pi.terra_job
```

Execute the code for $n=10^8$ with p chosen to be 2^k, for k = 0, 1, …, 6. Specify `ptile=4` in the job file. Using the experimental data obtained from these experiments, answer the following questions.

1. (10 points) Plot execution time versus p to demonstrate how time varies with the number of processes. Use a logarithmic scale for the x-axis.
2. (10 points) Plot speedup versus p to demonstrate the change in speedup with p.
3. (5 points) Using the definition: efficiency = speedup/p, plot efficiency versus p to demonstrate how efficiency changes as the number of processes is increased.
4. (5 points) What value of p minimizes the parallel runtime?
5. (10 points) With $n=10^9$ and p=64, determine the value of ptile that minimizes the `total_time`. Plot time versus ptile to illustrate your experimental results for this question.

6. (10 points) Repeat the experiments with p=64 for n=10^2, 10^4, 10^6 and 10^8.
    a. Plot the speedup observed w.r.t. p=1 versus n.
    b. Plot the relative error versus n to illustrate the accuracy of the algorithm as a function of n.

Submission: Upload a single PDF or MSWord document with your answers to ecampus.