CSCE 435 Spring 2021

HW 1: Parallel Programming with Threads

Due: 11:59pm Friday, February 12, 2021

Compile and execute the program in the file `compute_pi.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:

```
icc -o compute_pi.exe compute_pi.c -lpthread
```

To execute the program, use

```
./compute_pi.exe <n> <p>
```

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

```
./compute_pi.exe 1000000 4
Trials = 1000000, Threads = 4, pi =   3.1433480000, error = 5.59e-04, time (sec) =   0.0043
```

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

```
bsub < compute_pi.ada_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, …, 13. Using the experimental data obtained from these experiments, answer the following questions.

1. (20 points) Plot execution time versus p to demonstrate how time varies with the number of threads. Use a logarithmic scale for the x-axis.
2. (20 points) Plot speedup versus p to demonstrate the change in speedup with p.
3. (10 points) Using the definition: efficiency = speedup/p, plot efficiency versus p to demonstrate how efficiency changes as the number of threads are increased.
4. (10 points) What value of p minimizes the parallel runtime?
5. (10 points) Repeat the experiments with $n=10^9$ To obtain the execution time for $p=2^k$, for k = 0, 1, …, 13. In this case, what value of p minimizes the parallel runtime?
6. (10 points) Why does the runtime start to increase as p is increased beyond a certain value?

7. (10 points) Why is there a difference in the number of threads needed to obtain the minimum execution time for two values of n?
8. (10 points) Plot error versus n to illustrate accuracy of the algorithm as a function of n. You may have to run experiments with different values of n; for example n could be chosen to be 10^k, for k = 3, …, 9. Use p = 20.

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