

CSCE 435 Summer 2021

HW 1: Parallel Programming with Threads

Due: 11:59pm Monday, June 14, 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. It should be compiled and executed on `grace.hprc.tamu.edu`.

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

```
module load intel/2020a
```

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.grace_job` to execute the code in dedicated mode using the following command on Grace:

```
sbatch compute_pi.grace_job
```

Execute the code for $n=10^8$ with p chosen to be 2^k , for $k = 0, 1, \dots, 13$. 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: $\text{efficiency} = \text{speedup}/p$, 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 $k = 0, 1, \dots, 13$. 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 $k = 3, \dots, 9$. Use $p = 48$.

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