**Portland State University – ECE 588/688**

**Winter 2024**

**Homework 3**

Due Week 6 Sunday, Feb 18, 2023 Before 11:59 PM

Submit to Canvas

Points: 6

Write a program using pthreads to estimate the temperature of all points on a grid in a similar fashion to the algorithm provided in the parallel computing program:

[https://hpc.llnl.gov/documentation/tutorials/introduction-parallel-computing-tutorial##ExamplesHeat](https://hpc.llnl.gov/documentation/tutorials/introduction-parallel-computing-tutorial#ExamplesHeat)

You can start out by modifying the sample “sum.c” code, or write your own code from scratch.

You should use the following parameters:

1. Grid size = 1000 x 1000, spanning all points in the square between coordinates (1,1) and (1000,1000).
2. Initial condition: All center points in the region (200, 200) to (800, 800) have a temperature of 500 degrees, and all other points have a temperature of zero. Points outside the grid (i.e., neighbors of points on the boundary) always have a temperature of zero that does not change.
3. At each time step *t*, the temperature of a point at coordinates (x,y) is computed from the temperatures of the neighboring points in the previous time step *(t-1)* according to the following equation:

T(x,y)*(t)* = T(x,y)*(t-1)*

+ Cx \* (T(x+1,y)*(t-1)* + T(x-1,y)*(t-1)* – 2 T(x,y)*(t-1)*)

+ Cy \* (T(x,y+1) *(t-1)* + T(x,y-1) *(t-1)* – 2 T(x,y) *(t-1)*)

Where Cx=0.125 and Cy=0.11

1. Run the program for 4000 time steps. Note that depending on how you split your data, you may need to communicate information to neighboring processors after each time step.
2. After each 200 time steps, you should print the temperatures of the following points: (1, 1), (150,150), (400, 400), (500, 500), (750, 750), and (900,900).

You will get a better score if you do a good job parallelizing your algorithm to get a high parallel speedup.

You should turn in (1) a text file that contains the table of parallel speedups, and (2) a file with your C program. The file name has to be “YourLastname\_homework3.c”. Your program should run one command line parameters: the number of processors. When your program runs, it should produce one line of output for each of the points requested, and a line that displays runtime in this format:

Time = 98570173000 nanoseconds (98.5701733 sec)