New York University
Tandon School of Engineering
Department of Electrical & Computer Engineering

Introduction to Operating Systems (CS-GY6233)
Fall 2021

Assignment 5
(10 points)

Part 1 (4 points)

Repeat HW4, except that the two processes shall communicate using ordinary pipes.

Part 2 (6 points)

Write a program that calculates the area of a circle with unit radius (thus area = the value of π). This can be achieved by enclosing a circle inside a square of length 2 units.

Your program's main routine shall create 4 worker threads in order to speedup the computation and use a shared variable (an integer) as well as synchronization primitives (e.g. a semaphore).

Each of the worker threads shall generate 1,000,000 random points, each with an *(x,y)* coordinate, with *x* and *y* ranging between -1 and 1. Each thread shall then compute whether the point is inside the circle or not (it may do so by computing the radius $r = \sqrt{x^2 + y^2}$ and evaluating if it's <=1) and immediately increment the shared variable only if the point is inside the circle, i.e. the **updates shall not wait** for the entire 1,000,000 points to be computed but rather update the shared variable after each computation.

The main thread shall wait for all four worker threads to exist (at such point 4,000,000 points would have updated) and print the area of the circle as the $4 \times \frac{points\ inside}{total\ points}$

Note that you will need to use the -pthread option with gcc in order to link the pthread library.

Submission file structure:

Please submit a **single .zip file** named **[Your Netid]_lab#.zip**. It shall have the following structure (replace # with the actual assignment number):

```
└── [Your Netid] hw# (Single folder includes all your submissions)
    ├── lab#_1.c (Source code for problem 1)
    ├── lab#_2a.c (Source code for problem 2a, and so on)
    ├── lab#_1.h (Source code header file, if any)
    ├── Makefile  (makefile used to build your program, if any)
    ├── lab#.pdf (images + Report/answers to short-answer questions)
```

What to hand in (using Brightspace):

- Source files (.c or .h) with appropriate comments.
- Your Makefile if any.
- A .pdf file named **"lab5.pdf"**, containing:
    - Screen shot(**s**) of your terminal window showing the current directory, the command used to compile your program, the command used to run your program and the output of your program.

RULES:

- You shall **use kernel version 4.x.x or above**. You shall not use kernel version 3.x.x.
- You may consult with other students about GENERAL concepts or methods but copying code (or code fragments) or algorithms is NOT ALLOWED and is considered cheating (whether copied form other students, the internet or any other source).
- If you are having trouble, please ask your teaching assistant for help.
- You must submit your assignment prior to the deadline.