



Assignment 3

Answer the following questions. **You must follow the instructions for submission given in Section 3 below**; submissions that do not follow these instructions will not be graded and will be given a **zero grade**.

1 Questions

- (18%) For each of the following, select `shared` if it is shared among the threads in a multithreaded process, or select `private` if it is not.
 - Register values
 - Heap memory
 - Global variables
 - Stack memory
 - Program code
 - Program

- (18%) Including the original process, as a function of N , how many processes are created when the following program is executed?

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
int main(int argc, char* argv[])
{
    int i, N;
    N = ( argc > 1 ) ? atoi(argv[1]) : 0 ;
    for (i = 0; i < N; i++) {
        fork();
    }
    return 0;
}
```

- (32%) For each of the following applications, select `TRUE` if a multithreaded solution could provide better performance than a single-threaded solution, and `FALSE` otherwise.
 - A web server
 - A compiler that inputs a single high-level source code file and outputs an equivalent object file
 - An application that applies a filter to a digital photograph
 - A shell program such as `bash`
 - An application that finds all elements in an array of strings that match a given pattern
 - An application that uses the trapezoidal method to find the approximate definite integral of a given function
 - An application that prints the pages of a file in the order given by the page numbers supplied on the command line
 - An application that prints all lines that match a given pattern in a file whose name is supplied on the command line



4. (16%) Using Amdahl's Law, calculate the maximum possible speedup of an application that has a 60 percent parallelizable code when run on a machine with:
 - (a) two processors
 - (b) four processors
 - (c) eight processors
 - (d) What is an upper bound on that speedup if the number of processors is unlimited?
5. (16%) Write the detailed steps that take place in a modern Unix based system such as Linux when a process terminates, including the role of `init` (in some systems replaced by `systemd`) in this sequence of steps.

2 Grading Rubric

There are five questions in this assignment, each worth the percentage indicated. Questions are assessed on their completeness and correctness and graded in accordance with the *General Requirements for Assignments* document posted on the course website.

3 Instructions for Submitting the Homework

1. **Due Date:** This assignment is due by the end of the day (i.e. 11:59PM, EST) on October 9.
2. Your homework must comply with the *General Requirements for Assignments* document posted on the course website for full credit.
3. **The assignment must be typewritten, not hand-written, and submitted as a PDF.**
4. **You must put your name, first name followed by last name, in the upper left corner of the first page, which is nothing but a title page; it should have nothing else on it.**
5. **Each question must be answered on a separate page, and be no longer than one page in length.** There will be exactly six pages in total - a title page and five answer pages.
6. To submit the assignment, you must use the `submitpdf_cs340` program that is located in the directory

```
/data/biocs/b/student.accounts/cs340_sw/bin
```

If you did the first assignment correctly, then you can execute this program by typing its name, otherwise you will have to type the full path name to the file. The precise steps are:

- (a) If you have written the assignment on your own computer, upload it to `eniac` first, using either `sftp` or `scp` (on Mac systems in the terminal window or on Linux systems in a terminal window), or in Windows using the PuTTY file transfer agent called `psftp` or `pscp`. or the `ssh` client you installed from my website. If you have never used any of these, read the documentation that comes with it (such as man pages in Linux or the Mac.)
- (b) Login using `ssh` to `eniac.cs.hunter.cuny.edu` with your valid username and password, **and then ssh into any cslab host.**
- (c) Navigate (`cd`) to the directory into which you uploaded the assignment.
- (d) Assuming that the assignment is named `hwk3.pdf`, you must run the command

```
submitpdf_cs340 3 hwk3.pdf
```

Do exactly this. The command will create a copy of your file in the directory



```
/data/biocs/b/student.accounts/cs340_sw/hwks/hwk3
```

It will be named `hwk3_username.pdf`, where *username* is your username on the network. You will not be able to read this file, nor will anyone else except for me. If you decide to make any changes and resubmit, just run the command again and it will replace the old file with the new one. Do not try to put your file into this directory in any other way - you will not be able to do so.