

15-213: Introduction to Computer Systems

Written Assignment #11

This written homework covers Concurrent Programming and Synchronization.

Directions

Complete the question(s) on the following pages with single paragraph answers. These questions are not meant to be particularly long! Once you are done, submit this assignment on Canvas.

Below is an example question and answer.

Q: Please describe benefits of two's-complement signed integers versus other approaches.

A: Other representations of signed integers (ones-complement and sign-and-magnitude) have two representations of zero (+0 and -0), which makes testing for a zero result more difficult. Also, addition and subtraction of two's complement signed numbers are done exactly the same as addition and subtraction of unsigned numbers (with wraparound on overflow), which means a CPU can use the same hardware and machine instructions for both.

Grading

Each assignment will be graded in two parts:

1. Does this work indicate any effort? (e.g. it's not copied from a homework for another class or from the book)
2. Three peers will provide short, constructive feedback.

Due Date

This assignment is due on December 6th by 11:59pm Pittsburgh time (currently UTC-4). Remember to convert this time to the timezone you currently reside in.

Question #1

In the following vignette, classify the situation as an instance of deadlock, livelock, or starvation.

David, Phil, and Brian go to an all-you-can-eat buffet. They sit in a booth, with Brian seated between David and Phil. Brian is too polite to ask to be let out to get more food, so he only leaves to refill his plate when either David or Phil do. However, both David and Phil are very speedy and can leave the booth, refill their plates, and return before Brian has a chance to get out, so Brian never gets to refill his plate. Is this an instance of deadlock, livelock, or starvation (as it relates to concurrency)? Explain your reasoning.

This is a case of starvation.

Deadlock occurs when multiple processes are unable to proceed because each is waiting for the other to release a resource.

Livelock is a situation where processes are actively responding to each other's actions, but the system as a whole is not making progress.

Starvation is a condition where a process is unable to gain regular access to shared resources, and as a result, it is unable to make progress.

In this case, David and Phil can be seen as competing for the shared resource (access to the buffet). Brian is being starved because, due to the speedy nature of David and Phil, he is unable to access the buffet. Even though he's trying to get more food, the conditions prevent him from successfully doing so.

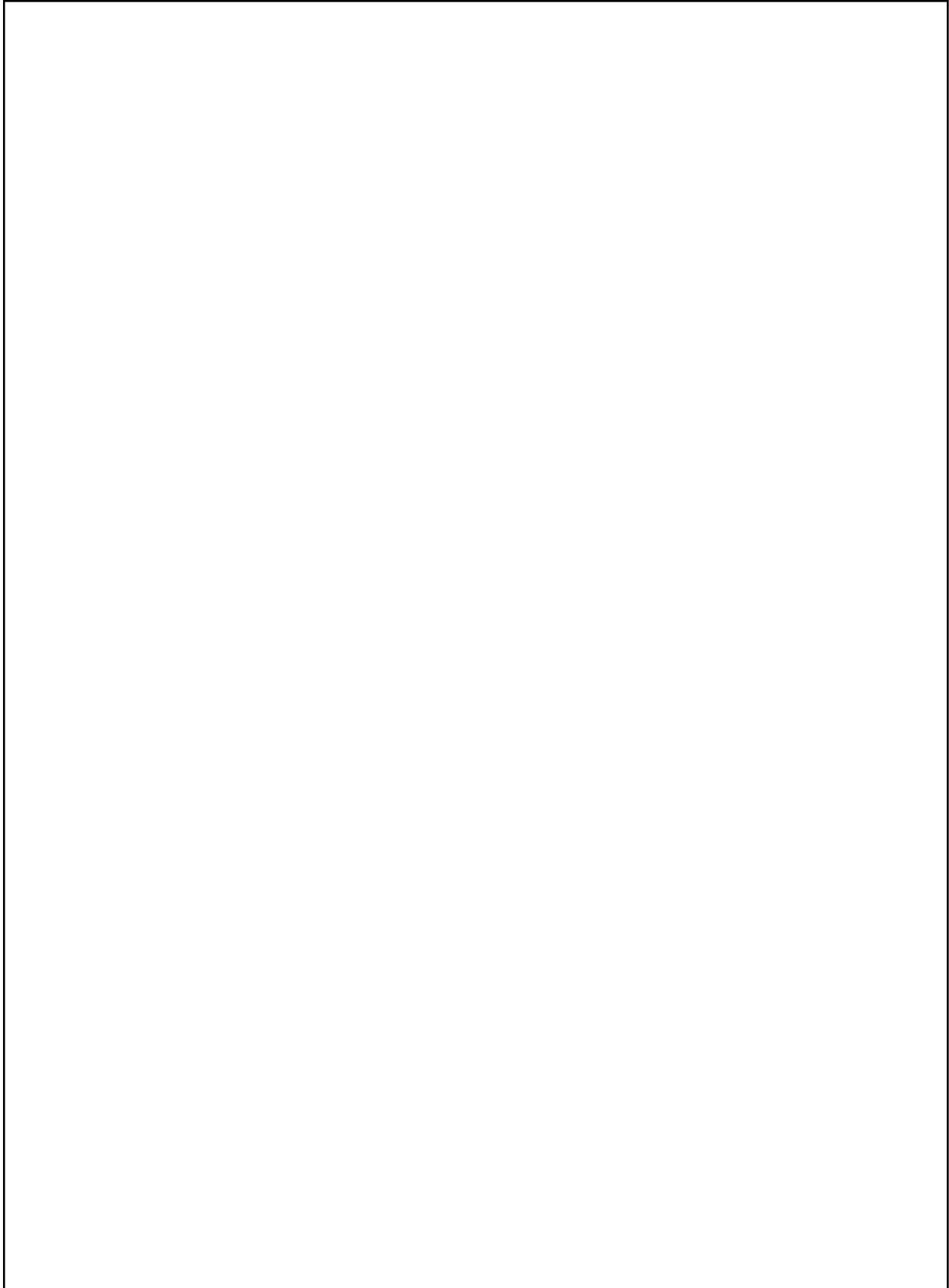
Question #2

Here is a thread routine that uses two global variables, **count1** and **count2**.

```
void* thread(void* argp) {
    long niters = ((long)argp);
    for (long i = 0; i < niters; i++) {
        if (i % 2 == 0) count1++;
        else count2++;

        if (count1 - count2 == 1)
            printf("yeet! ");
    }
    return NULL;
}
```

Assuming that there are multiple concurrent threads running this same thread routine, how many critical sections are in this code? Justify your answer. How would a programmer synchronize the critical section(s)?



Question #3

Identify two benefits of using concurrency. In particular, identify two specific metrics and explain how a concurrent program would be better than a sequential one for each metric. Include one benefit that remains true even if you are running code on a single processor.