Exam 2

Software Systems
Spring 2014

This exam is open book, open notes, open laptop.
For questions with numerical answers, please include appropriate, human-comprehensible units and indicate your answer clearly.
For short answer questions, your answers should be correct, concise, clear, grammatical and legible!

1 Think OS

1. If you accidentally write past the end of an array, you might see different results depending on how the array was allocated. If you are lucky, you get a segmentation fault. Otherwise, explain what effect is most likely to occur, and when the effect is likely to happen, if the array is statically allocated, stack allocated, or heap allocated.
2. Write a function called `assemble` that takes two `uint8_t` named `most` and `least`, and assembles and returns a `uint16_t`, with the bits from `most` on the left and the bits from `least` on the right.

For example, `assemble(1, 2)` should return 258.

3. Some schedulers give a longer quantum to processes with lower priority, which might sound strange at first. But why might it be a good idea?
4. If a process is blocked waiting for a block to be read from disk, explain the sequence of steps that would allow the process to resume running.

2 Homeworks

1. Suppose you are planning to deploy a web service that computes the Bacon distance between any two actors. You are considering two database designs:

   (a) One option is a database that contains two tables. One maps from each actor to a list of movies. The other maps from each movie to a list of actors.

   (b) The other option is a database with a single table that maps from each actor to a list of co-stars.

   Explain one advantage of the first option (relative to the second), and one advantage of the second option.
2. On systems like the Arduino, there are two ways to deal with real time deadlines: timer interrupts and the `delay()` function. Explain two advantages of using interrupts and one disadvantage.

3. According to Wikipedia, “As of 2010, a typical 7,200-rpm desktop HDD has a sustained ‘disk-to-buffer’ data transfer rate [of] 1,030 Mbits/sec.” If the same HDD takes 3.64 ms to move the read/write head to the right track, what is the total time to read a track that contains 100 blocks that are 8 KiB each? What implication does this have for disk cache policy?
3 C programming

If you run `git pull upstream master` in your local copy of the SoftwareSystems repo, you should get a directory named `exam2` that contains `vector.c` and `matrix2.c`.

1. `vector.c` contains an implementation of a Vector structure, but it contains several errors. Before you modify this file, print a copy using `a2ps` or something like it.

   Find and fix the errors. You can use the compiler. Then mark the errors on the printed copy and explains briefly what the problem was and how you fixed it. Make sure your name is on this paper and turn it in with your exam on Thursday.

   There are at least six errors. You can get full credit for finding four of them, but if you identify something as an error that is actually correct, you will lose some points.

2. In `matrix2.c`, fill in the body of `row_sum` so it does what the comment says it is supposed to.

   Push your corrected version of `matrix2.c` and `vector.c` to your SoftwareSystems repo on GitHub. Use the GitHub web interface to confirm that your changes are in your repo.

3. In `matrix2.c` there are two versions of `matrix_sum`: one traverses the rows and one traverses the columns. Assuming that the matrix is bigger than the memory cache and that a memory cache line is big enough to hold 8 matrix elements, what cache hit rate would you expect for each version of `matrix_sum`? Explain your reasoning.