Due: Midnight, February 20, 2020

1. `pmap` Utility

Start up two instances of the terminal window. Find the process ids for each of the bash shells in the two windows. Run the `pmap` utility on each of the process id's and answer the following questions:

a) There are a number of libraries included in the list. Search for each library (google or whatever) and, for each library, give a one sentence description of the library.
b) The same program, `bash`, is running in each process, other than the virtual page numbers, are they identical? Are any of the actual addresses the same?

2. Threads

Read chapter 26 on concurrency and answer the following questions:

a) What is the main difference between processes and threads?
b) Why would you use multiple threads in a program?
c) Linux exposes information on threads, like everything else, in the `/proc` filesystem. You can also use the `ps` command to see thread information. In your virtual machine, find an example of a process that has multiple threads and provide:
    a. The name (command) that is running
    b. The pid for the process
        i. For each thread show the pid for the thread

3. Memory and Concurrency

In the examples from the book, there is a `threads-intro` directory. Program `t1.c` starts up two threads and each thread increments a common global variable.

a) Make (build) the program and run it with various loop count parameter values in your Linux VM. How high do you need to get the loop count before the counter doesn't match the intended value?
b) Why do you think it needs to be this large before there are concurrence problems?
c) If I run the program the program natively on my 4 core Mac it starts failing at a much lower value than in the VM. Why would the increasing the number of cores cause the problem to occur sooner?