CS41 lab 2

In typical labs this semester, you'll be working on a number of problems in groups of 3-4 students. You will not be handing in solutions; the primary purpose of these labs is to have a low-pressure space to discuss algorithm design, and to gain experience collaborating with others on algorithm design and analysis. However, it will be common to have some overlap between lab exercises and homeworks.

The goal of this lab is to gain more experience with asymptotic analysis and algorithm design. There are more problems than you have time to complete during the lab. Consider it a successful lab session if you can mostly complete two problems.

1. **Post on Ed STEM.** If you haven't posted on EdSTEM yet, log onto the course forum on EdStem, and either ask a question, or respond to an existing post. The goal is to make sure everyone is comfortable using the forum for discussion; don't feel like this question/post has to be about computer science!

2. **Verifying git.** If you didn't get a chance to make an initial test submission with git commit/push, try doing that now. Then go to the Swarthmore Github and see if the commit is visible in the web interface. If you'd like, you can check with me and I can verify that I see it on my end. If you have any trouble with using git or LaTeX, let me know.

3. **Stable Matching.** Suppose there is an instance to the stable matching problem where there exists a student s and a hospital h such that h is first in the preference list for s (i.e., h is the most preferred hospital by s), and likewise s is first in the preference list for h (i.e., s is likewise the most preferred student for h). Is it always the case that every stable matching will pair h and s together? Give a proof or show a counterexample of such an instance together with a stable matching that does not pair s and h together.

4. **Asymptotic analysis properties, part 1.** Assume you have functions f, g, and h. For each of the following statements, decide whether you think it is true or false and give a proof or counterexample.

   (a) If f is $O(h)$ and g is $O(h)$, then $f + g$ is $O(h)$.

   (b) If f is $O(h)$ and g is $O(h)$, then $f \cdot g$ is $O(h)$.

5. **Asymptotic analysis properties, part 2.** Assume you have functions f and g such that $f(n)$ is $O(g(n))$. For each of the following statements, decide whether you think it is true or false and give a proof or counterexample.

   (a) $\log_2(f(n))$ is $O(\ln(g(n)))$.

   (b) $2^{f(n)}$ is $O(2^{g(n)})$.

   (c) $(f(n))^3$ is $O((g(n))^3)$.

   (d) If $g(n)$ is $O(h(n))$, then $f(n)$ is $O(h(n))$.

6. **Asymptotic analysis.** Arrange the following functions in ascending order of growth rate. That is, if g follows f in your list, then it should be the case that $f = O(g)$:

- $f_1(n) = n^{2.7}$
- $f_2(n) = \sqrt{5n}$
- $f_3(n) = n + 6$
- $f_4(n) = 10^n$
- $f_5(n) = 100^n$
- $f_6(n) = \log_{1.2}(n)\sqrt[4]{n}$
- $f_7(n) = n^n$
- $f_8(n) = n^2 \log_2(n)$
- $f_9(n) = n!$