

Analysis of Algorithms
CS 375, Spring 2019
Homework 1

Due **AT THE BEGINNING OF CLASS** Wednesday, February 13

- From your textbook (CLRS), please read:
 - Appendices A.1, B.1 pages 1158–1160, and B.4, covering the mathematical background topics of summations, sets, and graphs.
 - Chapters 1, 2.1, and 2.2.
- Unless otherwise specified, exercises will be from the CLRS textbook and will be named on HW assignments by exercise number used in the book.
- *A general note:* When writing up your homework, please write neatly and **explain your answers clearly**, giving all details needed to make your answers easy to understand. Graders may not award credit to incomplete or illegible solutions. Clear communication *is* the point, on every assignment.

Exercises

1. Exercise A.1.1 (pg. 1149).
2. Exercise 1.2.3 (pg. 14).
3. Design an *iterative* algorithm to find all the common elements in two sorted lists of numbers. For example, for input lists $[2, 5, 5, 5]$ and $[2, 2, 3, 5, 5, 7]$, the output should be the list $[2, 5, 5]$. What is the maximum number of comparisons your algorithm makes if the lengths of the two input lists are m and n , respectively?

Please give both a pseudocode description and an English description, to make it as easy as possible to understand the algorithm, and explain how you know it solves the problem correctly.

Note: Recall that there are different operations to add an element to a list (**append**, in Python) and to combine two lists into one (**extend**, in Python). If you use either or both in your answer, please make sure it is clear which operation is being used. Of course, you are also welcome to use other common list operations such as **insert** or **remove**, if you'd like!

4. Professor N. F. Ishent of the Portland Institute of Technology created the following Python implementation of the binary search algorithm, but as is common with Prof. Ishent's programs (which are generally referred to as "N. F. Ishent programs"), it takes too long! In fact, it is much slower than binary search should be with a sorted list L.

```

def binarySearch(x,L):
    if L == []:
        return False
    else:
        midValue = L[len(L)/2]
        if x < midValue:
            return binarySearch(x,L[0:len(L)/2])
        elif x > midValue:
            return binarySearch(x,L[len(L)/2+1:len(L)])
        else:
            return True

```

What makes it take so long? What is its actual time complexity?

5. (Another problem solving puzzle!) There are four people who want to cross a bridge, all of which begin on the same side. They have 17 minutes to get to the other side. As is common in these kinds of puzzles, however, there's a catch!

Because the bridge is old and weakened by time, a maximum of two people can cross the bridge at one time. Moreover, it's night time, and they have one—only one—flashlight. Any time people cross (whether one person or two people), they must have the flashlight with them, and the flashlight must be walked back and forth over the bridge (it can't, e.g., be thrown from one side to the other).

Person 1 takes 1 minute to cross the bridge, person 2 takes 2 minutes, person 3 takes 5 minutes, and person 4 takes 10 minutes. If a pair crosses the bridge together, they must walk together at the pace of the slower person.

Can all four of them get to the other side in 17 minutes? If so, how? If not, why not? Be sure to explain your answer!

(Note: Our course's recommended textbook (Levitin) notes that, according to a rumor on the Internet, interviewers at a well-known software company located near Seattle have given this problem to interviewees!)

Important: For this exercise, *explain the full thought process by which you arrived at your answer!* Or, if you aren't able to find a full answer, explain the thought process as far as you get with your reasoning. This exercise is intended to give practice with thinking through a problem and clearly expressing the design process for your solution. For example, one might say "First, we thought about sending [blah blah blah], but we then realized [blah blah blah]. Then, to address that, we thought [blah blah blah], but that didn't work because of [blah blah blah]. Because of that, we ...". (Please try to avoid using the word "blah" in your answer!)

If you have any questions about what's being asked, please feel free to ask your prof.! This is a classic puzzle—I hope you have some fun with it!