

CS 477/677 Analysis of Algorithms

Homework 4

Due September 29, 2020

Note: for the programming question upload separate files in the .c or .cpp format. Include any specific compiling instructions in the top comments section of your files.

1. (U & G-required) [20 points]

Answer the following questions:

- a) [5 points] Is mergesort a stable sorting algorithm?
- b) [5 points] Is quicksort a stable sorting algorithm?

For the initial version of quicksort discussed in class (non-randomized, first partitioning method:

- c) [5 points] Are arrays made up of all equal elements the worst-case input, the best-case input, or neither?
- d) [5 points] Are strictly decreasing arrays the worst-case input, the best-case input, or neither?

2. (U & G-required) [40 points]

(a) [20 points] Implement in C/C++ an algorithm to rearrange elements of a given array of n real numbers so that all its negative elements (strictly less than zero) precede all its positive elements (greater than or equal to zero). Your algorithm should be both time and space efficient. Show how your algorithm runs on the input $A = [4\ 3\ -2\ 0\ 2\ 9\ -1\ 10\ 0\ 5\ 23\ -4]$.

Note: Name your source file problem2.c or problem2.cpp.

3. (U & G-required) [20 points]

Consider the following problem: each of n visitors to a museum give their hand bags to the wardrobe attendant at the entrance. At the end of the day, the attendant gives the hand bags

back to customers in random order. Use an indicator random variable to compute the expected number of visitors who get back their own bag.

4. (U & G-required) [20 points]

A toy company makes small electronic gadgets. Their production line is not perfect and due to that one out of every 50 toys is defective. The company only finds out which items are defective until a customer complains. Assume that the company makes a \$3 profit for any working gadget, but has a loss of \$80 for every defective one due to the cost for repairs. Indicate whether the company can expect to make a profit in the long term.

5. (G-Required) [20 points]

In a county with 100,000 people there is an election for the county top administrator. On the ballot there are two candidates only: one from the Green party (G) and one from the Yellow party (Y). The county is heavily leaning toward the Green party, therefore 80,000 people go to the polls with the intention for voting for G, and 20,000 with the intention of voting for Y. However, the ballots are a bit confusing, so that each voter, independently, and with probability of $1/100$, votes for the wrong candidate (i.e., the one they did not intent to vote for). Let X denote the random variable equal to the number of votes received by the Green candidate G, when the voting is done with this process of error. Compute the expected value for X , and give an explanation of your derivation for this value.

Extra credit

5. [20 points] Problem 7-2 (page 186). Answer only questions (a), (c) and (d). For (c) and (d) assume that you have the procedure at point (b) available.