CS 477/677 Analysis of Algorithms

Spring 2024

Homework 4

Due date: March 5, 2024

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

Implement in C/C++ **a divide and conquer algorithm** that computes the number of *pairs of adjacent equal elements* in an array of integer values. The algorithm should run in $\theta(nlgn)$ in the average case. For instance, for the array `[3 3 3 2 4 4]` there are the following adjacent pairs with identical elements (shown in parentheses): `[(3 3) 3 2 4 4]`, `[3 (3 3) 2 4 4]` and `[3 3 3 2 (4 4)]`. Show how your algorithm runs on the following input: `A = [1 2 2 4 5 5 6 7 7 3 3 3 8 9 8 8]`. **After** each combine step, and before returning from the recursive call, your algorithm **should print** the following: 1) the array that was used as input for the current call, and 2) the number of pairs computed for that input. **Note:** Submit your source code (in a file named `problem1.c` or `problem1.cpp`) as well as an image with the program output (in a file named `output1`, with JPG or PDF extension).

2. (U&G-required) [30 points]

(a) [15 points] Suppose you are playing a game where you are flipping 2 fair dice. If the sum of the two dice comes up even you earn **$6 per dice** and if the sum is odd you lose **$2 for each dice**. What is the expected value of your earnings if playing this game?

(b) [15 points] In a box, I have 40 marbles: 6 red, 5 yellow, 10 blue, 14 green and 5 black. I select one marble at random from the urn, and I win money based on the following rule: red ($8), yellow ($6), blue ($4), green ($2), black ($0). What is the expected value of my winnings?

3. (U & G-required) [30 points] Answer the following questions:

(a) [15 points] For the second `PARTITION` algorithm discussed in class, what value of `q` does it return when all elements in the array `A[p…r]` have the same value?

(b) [15 points] Suppose that `RANDOMIZED-SELECT` is used to select the minimum element of the array `A = [2, 3, 0, 5, 7, 9, 1, 8, 6, 4]`. Describe a sequence of partitions that results in a worst-case performance of `RANDOMIZED-SELECT`.

4. (G-required) [20 points] Write pseudocode for an iterative version of `RANDOMIZED-SELECT`.

Extra credit:

5. [20 points] Suppose you have a bag with 30 slips of paper in it. Some of the slips have a 14 on them and the rest have an 8 on them. If the expected value of the number shown on a slip randomly drawn from the bag is 10, then how many slips have an 8?