CSCI 3104 Fall 2021
Instructors: Profs. Grochow and Waggoner

Quiz- Standard 18

Due Date ..... October / 31^{st} / 2021
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Contents

1 Instructions

- The solutions **should be typed**, using proper mathematical notation. We cannot accept hand-written solutions. Here's a short intro to LaTeX.
- You should submit your work through the **class Canvas page** only. Please submit one PDF file, compiled using this LaTeX template.
- You may not need a full page for your solutions; pagebreaks are there to help Gradescope automatically find where each problem is. Even if you do not attempt every problem, please submit this document with no fewer pages than the blank template (or Gradescope has issues with it).
- You **may not collaborate with other students**. **Copying from any source is an Honor Code violation. Furthermore, all submissions must be in your own words and reflect your understanding of the material.** If there is any confusion about this policy, it is your responsibility to clarify before the due date.
- Posting to **any** service including, but not limited to Chegg, Discord, Reddit, StackExchange, etc., for help on an assignment is a violation of the Honor Code.
- You **must** virtually sign the Honor Code (see Section **??**). Failure to do so will result in your assignment not being graded.

2 Honor Code (Make Sure to Virtually Sign)

Problem 1.

- My submission is in my own words and reflects my understanding of the material.
- I have not collaborated with any other person.
- I have not posted to external services including, but not limited to Chegg, Discord, Reddit, StackExchange, etc.

- I have neither copied nor provided others solutions they can copy.

I agree to the above, Michael Ghattas. □

3 Standard 18: Divide and Conquer.

Problem 2. Given an array $A[1, ..., n]$, we say it contains a duplicate if there are two distinct indices $i \neq j$ such that $A[i] = A[j]$. Consider the following divide and conquer algorithm for counting the number of duplicates.

```
countDuplicates (A[1, ..., n], integer p, integer q):
    if length(A) == 2 {
        if A[0] == A[1] {
            return 1
        }
        else {
            return 0
        }
    }
    if q > p {
        r = floor ((p+q)/2)
        L = countDuplicates (A, p, r)
        R = countDuplicates (A, r+1, q)
        return L + R
    }
    else {
        return 0
    }
```

Will the above algorithm return the correct number of duplicates? **Explain and justify** your answer by computing `countDuplicates(A, 1, n)` and showing what the algorithm does at each step. If the algorithm does not correctly count duplicates, give an example to illustrate that the algorithm fails.

Answer:

First it is important to note the ambiguity of what integers p and q represent! It has not been specified that they represent the *Start/Smallest* and *End/Largest* values in the array.

First we will assume the intent here is integer p represents the *Smallest* value, while integer q represents the *Largest* value in the array.

We proceed with our example where $A[3, 6, 6, 3]$, $p = 3$, and $q = 6$.

- Since $A[0] != A[1]$, the function returns 0 and proceeds to the next if statement
- $(q = 6) > (p = 3) \rightarrow r = floor\frac{3+6}{2} = 4$
- $L = countDuplicates(A, 3, 4)$ is called
- Since $A[0] != A[1]$, the function returns 0 and proceeds to the next if statement
- $(q = 4) > (p = 3) \rightarrow r = floor\frac{3+4}{2} = 3$
- $L = countDuplicates(A, 3, 3)$ is called
- Since $A[0] = A[1]$, the function returns 1and proceeds to the next if statement
- $R = countDuplicates(A, (4 + 1), 6)$ is called
- Since $A[0] != A[1]$, the function returns 0 and proceeds to the next if statement
- $(q = 6) > (p = 5) \rightarrow r = floor\frac{5+6}{2} = 5$
- $R = countDuplicates(A, (5 + 1), 6)$ is called

- Since $A[0] = A[1]$, the function returns 1and proceeds to the next if statement
- The function return $L + R = 2$
- The function returns 0 and terminates successfully identifying 2 duplicates

- **Now we will assume the intent here is integer p represents the $Start$ value, while integer q represents the End value in the array.**
- **Now we proceed with our example where $A[3, 6, 6, 3]$, $p = 3$, and $q = 6$.**
- Since $A[0]! = A[1]$, the function returns 0 and proceeds to the next if statement
- $(q = 3) > (p = 3) \rightarrow r = floor\frac{3+3}{2} = 3$
- $L = countDuplicates(A, 3, 3)$ is called
- Since $A[0] = A[1]$, the function returns 1and proceeds to the next if statement
- $R = countDuplicates(A, (3 + 1), 3)$ is called
- Since $A[0]! = A[1]$, the function returns 0 and proceeds to the next if statement
- $(q = 3) < (p = 4)$
- The function return $L + R = 1$
- The function returns 0 and terminates unsuccessfully identifying only 1 duplicate

Thus we conclude that the function does not always work as intended and the algorithm fails.

□