CSCI 3104 Quiz 4

Jonathan Phouminh

TOTAL POINTS

12.5 / 18

QUESTION 1

8 pts

1.1 1 / 1

✓ **+ 1 pts** **Correct Pivot Value**

+ 0 pts Incorrect Pivot Value

1.2 1 / 2

+ 1 pts Iterations Correct - 2 iterations in entire Partition call

✓ **+ 1 pts** **Value of left valid for some interpretation**

+ 0 pts Incorrect

1.3 2 / 2

✓ **+ 1 pts** **Iterations Correct - 2 iterations in entire Partition call**

✓ **+ 1 pts** **Value of right correct for interpretation used in part b**

+ 0 pts Incorrect

1.4 1 / 2

✓ **+ 1 pts** **Correctly lists 7 with 2 (and optionally 4 with itself)**

+ 1 pts No extra swaps

+ 0 pts Incorrect

1.5 0 / 1

+ 1 pts Correct value of (Left = 4 or Right = 2 depending on version)

✓ **+ 0 pts** **Incorrect**

QUESTION 2

2 2 / 3

+ 3 pts Correct

+ 2 pts The complete order is not correct.

✓ **+ 2 pts** **Please list the order of complete calls starting from 1.**

+ 1 pts The tree is not complete.

+ 0 pts Not correct

+ 0 pts No answer

QUESTION 3

3 3 / 3

✓ **+ 3 pts** **Correct partitioning and recursion**

+ 0 pts Unless otherwise specified, use the standard deterministic algorithm from class

- 0.5 pts Unnecessary and additional recursive calls

- 0.5 pts Minor errors in partitioning

+ 0.5 pts Significant errors in partitioning

+ 0 pts No answer or incorrect

+ 1 pts Some progress, but incomplete or incorrect answer

+ 1 pts Recurses on both sub-arrays

+ 1 pts Correct initial partitioning step

+ 1 pts Correct second partition step

+ 0.5 pts Correct description of algorithm, but did not work through the algorithm

+ 2.5 pts What is the kth smallest element?

+ 1.5 pts Correct answer, but did not clearly spell out partitioning steps.

+ 0.5 pts Some correct work, but very unclear work or mostly incorrect work.

QUESTION 4

4 2.5 / 4

(a)

+ 1 pts (a) is correct.

✓ **+ 0.5 pts** **(a) is not correct but with structure explanation.**

+ 0 pts Click here to replace this description.

(b) Each pair(value and parent) is 1 point.

+ **3 pts** three pairs(value and parent) are right.
+ **2.5 pts** 5 items are right
✓ **+ 2 pts 4 items are right**
+ **1.5 pts** 3 right
+ **1 pts** 2 right
+ **0.5 pts** 1 right
+ **0 pts** 0 right

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CSCI 3104, Algorithms
Quiz 4 – 18 points total

Profs. Hoenigman & Agrawal
Fall 2019, CU-Boulder

Instructions: This quiz is open book and open note, but an individual effort. Electronic devices are not allowed on your person (including in your pocket). Possession of such electronics is grounds to receive a 0 on this quiz. Proofs should be written in **complete sentences. Show all work to receive full credit.**

Please provide these:
Left neighbor name : Jennifer Palese
Right neighbor name : X

We provide the Master Theorem for your reference.

Master Theorem: Suppose $T(n) = aT(n/b) + f(n)$, where $a \geq 1$ and $b > 1$.

(a) If there exists $c < \log_b(a)$ such that $f(n) \in \Theta(n^c)$, then $T(n) \in \Theta(n^{\log_b(a)})$.

(b) If $f(n) \in \Theta(n^{\log_b(a)})$, then $T(n) \in \Theta(n^{\log_b(a)} \log(n))$.

(c) If $f(n) \in \Theta(n^c)$, where $c > \log_b(a)$, then $T(n) \in \Theta(f(n))$.

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1. (8 pts) Consider the following algorithm for Quicksort that uses a slightly different Partition algorithm than the ones we've learned so far.

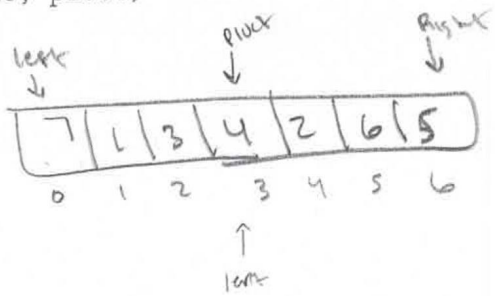
```
Quicksort(arr, left, right)
    if left >= right:
        return
    pivot = arr[floor((left+right)/2)]
    index = Partition(arr, left, right, pivot)
    Quicksort(arr, left, index-1)
    Quicksort(arr, index, right)

Partition(arr, left, right, pivot)
    while(left <= right)
        while(arr[left] < pivot)
            left++

        while(arr[right] > pivot)
            right--

        if(left <= right)
            swap(arr[left], arr[right])
            left++
            right--
    return left
```

Takes the middle element as pivot



(a) (1 pt) For the following initial call to Quicksort with the following parameters, what is the value of pivot that gets passed to Partition()?

```
arr = [7, 1, 3, 4, 2, 6, 5]
Quicksort(arr, 0, 6)
```

Solution. pivot = 4

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(b) (2 pt) In the first call to Partition, how many times will $while(arr[left] < pivot)$ iterate and what will be the value of $left$ when this loop terminates?

Solution. It will not execute any times on the value of left will still be 0

(c) (2 pt) In the first call to Partition, how many times will $while(arr[right] > pivot)$ iterate and what will be the value of $right$ when this loop terminates?

Solution. It will iterate twice and the value will be, right = 4

(d) (2 pt) List all values that are swapped in this call to Partition.

Solution.

7, 2 are swapped
1, 4 are swapped
3 is swapped with itself

(e) (1 pt) What is the value of $left$ when this call to Partition returns?

Solution. Value of left is 3 when returned

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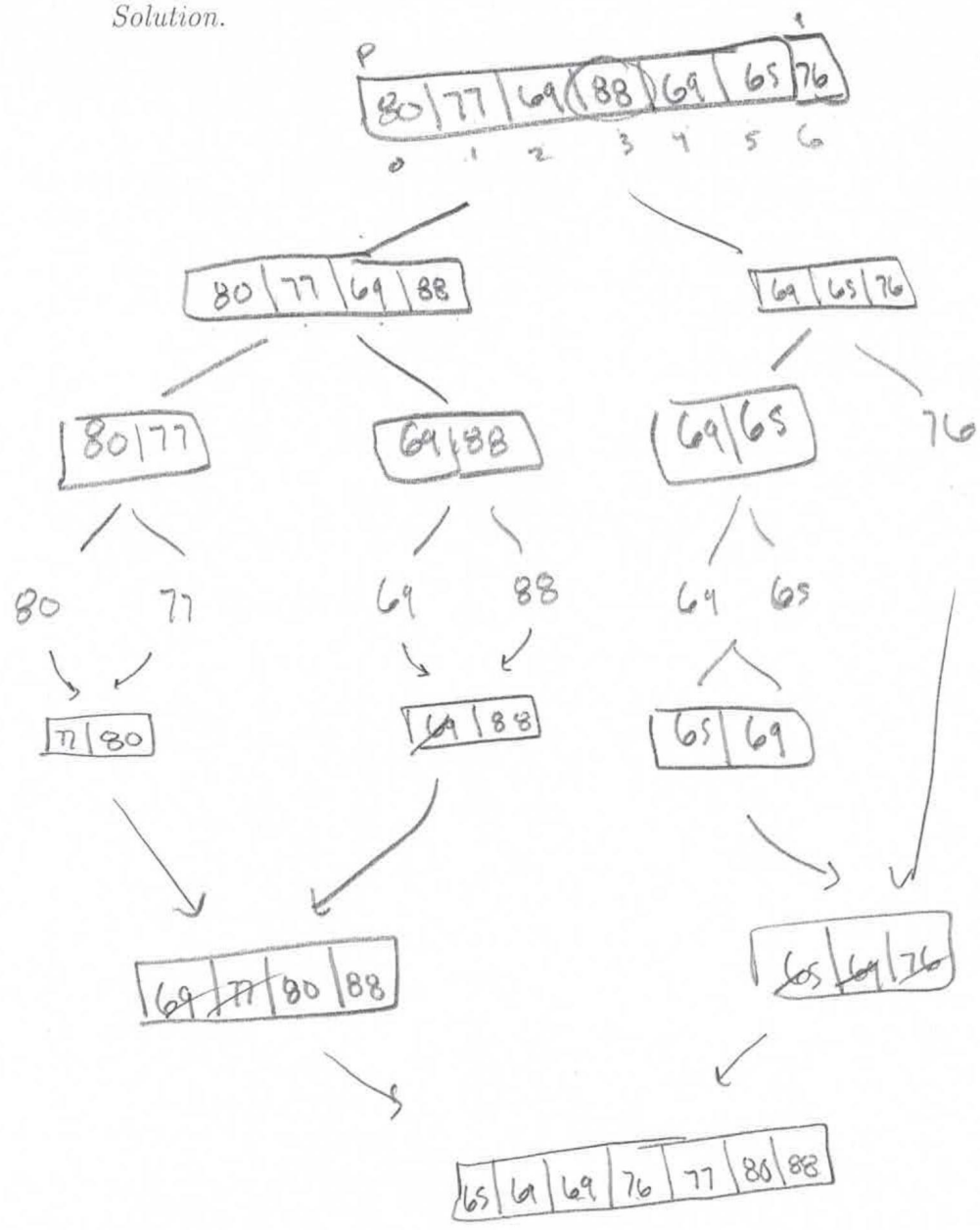
2. (3 pts) Show the recursion tree with the appropriate sub-problem when you apply MergeSort on the array $[80, 77, 69, 88, 69, 65, 76]$ and mention the order in which the calls will **complete**. You can assume that the left call happens before the right call.

Solution.



1. left subtrees will be broken down first
2. then right subtrees will be broken dow
3. merging will happen from left to right

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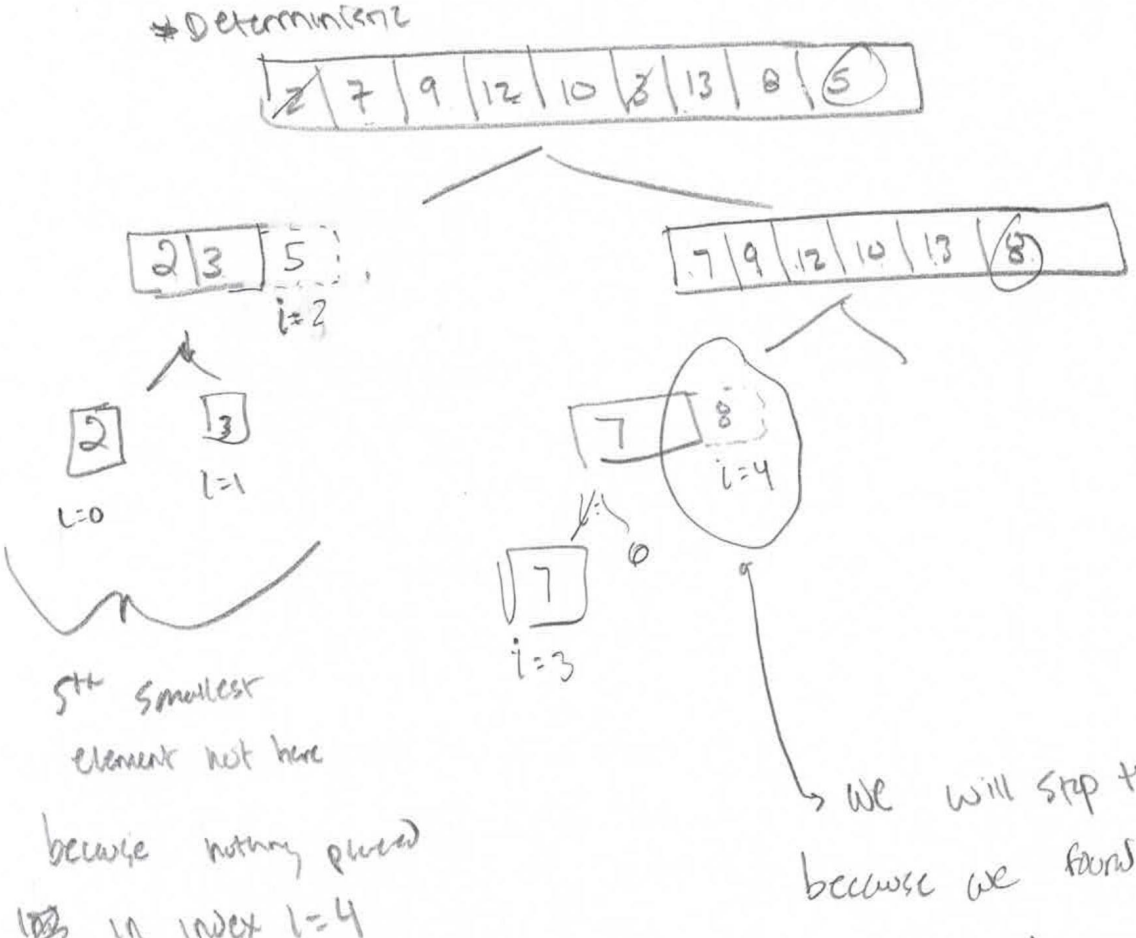
3. (3 pts) Illustrate how to apply the QuickSelect algorithm to find the $k = 5$th smallest element in the given array: A = [2, 7, 9, 12, 10, 3, 13, 8, 5] by showing the recursion call tree and the new k that you are looking for in each of those recursive calls.

Solution. We find the k=5th smallest element by applying essentially the quicksort algorithm until we find a pivot that is placed at index i=4 because that will be the rightful spot of the pivot and that index will always hold the 5th smallest element



5 that this is the location of the 5th smallest element and that this item is in its correct position!

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4. (4 pts) Consider the DP table for the Knapsack problem with $W = 8$, and a list of items $A = [(1,3),(2,6),(4,5),(3,8),(4,12)]$ of (weight, value) pairs.

W = 8		k \ w	0	1	2	3	4	5	6	7	8
Weight	Value	0	0	0	0	0	0	0	0	0	0
1	3	1	0	3	3	3	3	3	3	3	3
2	6	2	0	3	6	9	9	9	9	9	9
4	5	3	0	3	6	9	9	11	14	14	14
3	8	4	0	3	6	9	11	14	17	17	17
4	12	5	0	3	6	9	12	15	18	21	23

12 + 11

(a) (1 pt) What subproblem does $table[3][6]$, where $k = 3$ and $w = 6$, contain the optimal answer to?

Solution.

optimal subproblem to when considering items (1,3),(2,6) and knapsack only has carrying capacity of 2

A[2][2]

(b) (3 pts) Fill in the remaining 3 cells with the optimal values and also draw the arrow to show which sub-problem is the parent of each of these 3 cells.
(You can either write on the table or just fill the table like $table[1][1] = 3$ and it's parent = "correct cell")

Solution.

in table