(CSCI 251) Activity One and Exam One Review

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***Instruction:*** *The students are encouraged to type the answer use WORD and submit the word file through blackboard. To learn how to type math notation in word, please watch video* [*https://www.youtube.com/watch?v=SRGaW3maK38*](https://www.youtube.com/watch?v=SRGaW3maK38)*. You may search other videos to learn how to do this faster.*

*However, if the student feels it takes too much time to type the answer, then the student can use handwriting to write down the answers on paper. The students then scan the paper into pdf or image file then upload the file to blackboard. In this case, any unclear handwriting may result 0 points to the problem.*

*Exam One consists of two parts. Part One is online multiple choices/fill in blanks. The students should review the embedded homework problems to prepare Part One. This activity is Practice Problem Set for Exam One Part Two review. The questions in real Exam One may not be the same questions listed here. However, the testing concepts will be the same or similar.*

Problem One (8 points) In your textbook, the binary search is presented in iteration format. Please rewrite the binary algorithm in recursive format. You should write the algorithm in the follow format. The italic parts are the parts you need to modify.

Input: Let array be an array of elements which is sorted from index low to index high. Let key be an element to search for in the array.

Output: Return the index at which key is found in the array, or -1 if the key is not found in the array.



Problem Two (8 points, 4 points each) Consider the following array:

12, 13, 15, 15, 16, 16, 16, 19, 23, 24, 25, 26, 29, 30, 31 ,32

1. If use linear search algorithm from your textbook with search key 16, what is the return value? **The return value is 4.**
2. If use binary search algorithm from your textbook with search key 16, what is the return value? **The return value is 4.**

Problem Three (8 points, 4 points each)

You shall have studied this one in CSCI 241. If you have forgot, please review corresponding materials in Chapter Six Additional Materials

1. Order the following big O notation, from the fastest running time to slowest running time.
2. Determine big O notation for function

Problem Four (10 points, 5 points each) Write the following algorithms. The algorithms are all named isSorted. We assume an array object know its size,

1. The first algorithm returns true if the array is sorted either in ascend order or in descend order; returns false otherwise. The algorithm takes an int array as argument.



1. The second algorithm takes an int array and a Boolean value as arguments. If the Boolean value is true, then the algorithm returns true if the array is sorted in ascend order; If the Boolean value is false, then the algorithm returns true if the array is sorted in descend order; The algorithm returns false otherwise



Problem Five (16 points, 8 points each) Do NOT write code, just algorithm.

1. Modify the insertion sort algorithm with an extra argument, named isAscend, of Boolean type. If isAscend is true, then the array will be sorted in ascend order; otherwise, the array will be sorted in descend order.



1. Do the same problem to select sort algorithm.



Problem Six (Total 18 points, 3 points each for first 4 sub-problems, 6 points for number five) Answer the questions based on book’s Quick Sort algorithm.

1. What is the running time of partition?

**O(n)**

1. What is the running time of quick sort?

**O(n log n)**

1. How many times the partition algorithm will be executed in a quick sort? Assume the array size is n. Justify your answer.

**Every time the partition algorithm is run for a pivot, it puts the element at pivot into its final position. Therefore, the Partition algorithm should run no more than n times.**

1. How many comparisons are needed to sort a list of 2048 elements?

**(Worst Case)**

1. Given array 8, 5, 3, 7, 1, 6, 4, 2. List array to show the array changes in memory. You may list out array after each partition call is terminated.

**For Quicksort, the array will look as follows after each call:**

**8 5 3 7 1 6 4 2**

**1 5 3 7 8 6 4 2**

**1 5 3 7 2 6 4 8**

**1 2 3 7 5 6 4 8**

**1 2 3 4 5 6 7 8**

Problem Seven (Total 18 points, 3 points for first 5 sub-problems; 6 points for number five) Answer the questions based on book’s merge sort algorithm

1. What is the running time of merger?

**O(n)**

1. What is the running time of merger sort?

**O(n log n)**

1. How many times the merger algorithm will be executed in a merger sort?

**n - 1**

1. How many comparisons are needed to sort a list of 2048 elements?

**(Worst Case)**

1. Given array 8, 5, 3, 7, 1, 6, 4, 2. List array to show the array changes in memory. You may list out array after each merge call is terminated.

**For Mergesort, the array will look as follows after each call (numbers between ‘|’ are considered sorted):**

**| 8 | 5 | 3 | 7 | 1 | 6 | 4 | 2 |**

**| 5 8 | 3 | 7 | 1 | 6 | 4 | 2 |**

**| 5 8 | 3 7 | 1 | 6 | 4 | 2 |**

**| 5 8 | 3 7 | 1 6 | 4 | 2 |**

**| 5 8 | 3 7 | 1 6 | 2 4 |**

**| 3 5 7 8 | 1 6 | 2 4 |**

**| 3 5 7 8 | 1 2 4 6 |**

**| 1 2 3 4 5 6 7 8 |**

Problem Eight (7 points) According to your book, “…To partition the input, quicksort chooses a pivot to divide the data into low and high parts. The pivot can be any value within the array being sorted, commonly the value of the middle array element.” Now rewrite the partition algorithm by using the last element of the subarray as the pivot.



Problem Nine (7 points) What is the difference between stable and unstable sorting algorithms? For the sorting algorithms you studied in this chapter, which are stable? Which are unstable?

**A stable sorting algorithm preserves the order of elements which are considered equal when compared, while unstable sorting algorithms don’t preserve the order of comparatively equal elements.**

**Stable: Merge Sort, Insertion Sort, Bubble Sort**

**Unstable: Quicksort, Selection Sort**