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CSCI3320 Written Assignment #2

1. (30 pts) Sort 12, 4, 3, 9, 18, 7, 2, 17, 13, 1, 5, and 6 using…
   a. Bubble sort (5 pts)

Original	12	4	3	9	18	7	2	17	13	1	5	6
1	4	3	9	12	7	2	17	13	1	5	6	18
2	3	4	9	7	2	12	13	1	5	6	17	18
3	3	4	7	2	9	12	1	5	6	13	17	18
4	3	4	2	7	9	1	5	6	12	13	17	18
5	3	2	4	7	1	5	6	9	12	13	17	18
6	2	3	4	1	5	6	7	9	12	13	17	18
7	2	3	1	4	5	6	7	9	12	13	17	18
8	2	1	3	4	5	6	7	9	12	13	17	18
9	1	2	3	4	5	6	7	9	12	13	17	18
10	1	2	3	4	5	6	7	9	12	13	17	18
11	1	2	3	4	5	6	7	9	12	13	17	18

   b. Selection-sort (5 pts)

Original	12	4	3	9	18	7	2	17	13	1	5	6
1	1	4	3	9	18	7	2	17	13	12	5	6
2	1	2	3	9	18	7	4	17	13	12	5	6
3	1	2	3	9	18	7	4	17	13	12	5	6
4	1	2	3	4	18	7	9	17	13	12	5	6
5	1	2	3	4	5	7	9	17	13	12	18	6
6	1	2	3	4	5	6	9	17	13	12	18	7
7	1	2	3	4	5	6	7	17	13	12	18	9
8	1	2	3	4	5	6	7	9	13	12	18	17
9	1	2	3	4	5	6	7	9	12	13	18	17
10	1	2	3	4	5	6	7	9	12	13	17	18
11	1	2	3	4	5	6	7	9	12	13	17	18

   c. insertion sort (5 pts)

Original	12	4	3	9	18	7	2	17	13	1	5	6
1	4	12	3	9	18	7	2	17	13	1	5	6
2	3	4	12	9	18	7	2	17	13	1	5	6
3	3	4	9	12	18	7	2	17	13	1	5	6
4	3	4	9	12	18	7	2	17	13	1	5	6
5	3	4	7	9	12	18	2	17	13	1	5	6
6	2	3	4	7	9	12	18	17	13	1	5	6

7	2	3	4	7	9	12	17	18	13	1	5	6
8	2	3	4	7	9	12	13	17	18	1	5	6
9	1	2	3	4	7	9	12	13	17	18	5	6
10	1	2	3	4	5	7	9	12	13	17	18	6
11	1	2	3	4	5	6	7	9	12	13	17	18

d. shell sort using the increments {1, 3, 7} (5 pts)

- Colors are to help match increments {1,3,7}

0th	12	4	3	9	18	7	2	17	13	1	5	6
1st (7)	12	4	1	5	6	7	2	17	13	3	9	18
2nd (3)	2	4	1	3	6	7	5	9	13	12	17	18
3rd (1)	1	2	3	4	5	6	7	9	12	13	17	18

e. quick sort with median-of-three partitioning and a cutoff of 4. (10 pts)

Quick Sort w/ median of three and cutoff of 4												
Original	12	4	3	9	18	7	2	17	13	1	5	6
After Median3	6	4	3	9	18	7	2	17	13	1	5	12
Swap (7,5)	6	4	3	9	18	5	2	17	13	1	7	12
Swap (9,1)	6	4	3	1	18	5	2	17	13	9	7	12
Swap (18,2)	6	4	3	1	2	5	18	17	13	9	7	12
Swap (18,7)	6	4	3	1	2	5	7	17	13	9	18	12
Break												
s1, Pivot, s2	6	4	3	1	2	5	7	17	13	9	18	12
After Median3	1	4	3	5	2	6	7	9	13	12	18	17
Swap (5,2), (18,12)	1	4	3	2	5	6	7	9	13	18	12	17
Swap (13,12)	1	4	3	2	5	6	7	9	12	18	13	17
Break												
s1, Pivot, s2	1	4	3	2	5	6	7	9	12	18	13	17
Insertion Sort all	1	2	3	4	5	6	7	9	12	13	17	18
	1	2	3	4	5	6	7	9	12	13	17	18

2. (5 points) Answer the following questions.

i) (3 pts) List all inversions in the following input:

- Yellow: Number to move
- Green: Previous Number
- Blue: Sorted Array

Original, Swaps = 0	7	9	2	17	3	4	18	13	1	5	6
Swaps += 8	1	7	9	2	17	3	4	18	13	5	6
Swaps += 2	1	2	7	9	17	3	4	18	13	5	6
Swaps += 3	1	2	3	7	9	17	4	18	13	5	6
Swaps += 3	1	2	3	4	7	9	17	18	13	5	6
Swaps += 5	1	2	3	4	5	7	9	17	18	13	6
Swaps += 5	1	2	3	4	5	6	7	9	17	18	13
Swaps += 2	1	2	3	4	5	6	7	9	13	17	18
Swaps = 28											

All Inversions (28): (13,1), (18,1), (4,1), (3,1), (17,1), (2,1), (9,1), (7,1), (9,2), (7,2), (17,3), (9,3), (7,3), (17,4), (9,4), (7,4), (13,5), (18,5), (17,5), (9,5), (7,5), (13,6), (18,6), (17,6), (9,6), (7,6), (18,13), (17,13)

ii) (2 pts) By swapping 9 and 1, how many inversions will be removed (including the inversions added to the list)?

Original, Swaps = 0	7	9	2	17	3	4	18	13	1	5	6
Swaps += 1	7	1	2	17	3	4	18	13	9	5	6
Swaps += 1	1	7	2	17	3	4	18	13	9	5	6
Swaps += 1	1	2	7	17	3	4	18	13	9	5	6
Swaps += 2	1	2	3	7	17	4	18	13	9	5	6
Swaps += 2	1	2	3	4	7	17	18	13	9	5	6
Swaps += 5	1	2	3	4	5	7	17	18	13	9	6
Swaps += 5	1	2	3	4	5	6	7	17	18	13	9
Swaps += 0	1	2	3	4	5	6	7	17	18	13	9
Swaps += 3	1	2	3	4	5	6	7	9	17	18	13
Swaps += 2	1	2	3	4	5	6	7	9	13	17	18
Swaps = 22											

6 inversions will be removed by swapping 9 and 1

(5 pts) Consider the following pivot selection schemes and discuss the complexity for random inputs, pre-sorted inputs, and reverse-order inputs.

- **Average case complexity is discussed in the complexity analysis**
  a. Scheme 1: Pick the first element as a pivot
     i. **Random: O(N log N)**
     ii. **Pre-Sorted Inputs: O(N^2)**
     iii. **Reverse-Sorted Inputs: O(N^2)**
  b. Scheme 2: Pick the last element as a pivot
     i. **Random: O(N log N)**
     ii. **Pre-Sorted Inputs: O(N^2)**
     iii. **Reverse-Sorted Inputs: O(N^2)**
  c. Scheme 3: Pick the center element as a pivot
     i. **Random: O(N log N)**
     ii. **Pre-Sorted Inputs: O(N log N)**
     iii. **Reverse-Sorted Inputs: O(N log N)**
  d. Scheme 4: Median-of-three pivot selection
     i. **Random: O(N log N)**
     ii. **Pre-Sorted Inputs: O(N log N)**
     iii. **Reverse-Sorted Inputs: O(N log N)**

3. (5 pts) If you must recommend only one pivot selection scheme from the list given in the previous problem. Which one do you recommend? Justify your answer.

   I would recommend using the Median-of-three sorting algorithm, although it does add overhead to the algorithm, it also ensures that, for the worst case time complexity analysis, (using big-oh) will be O(N log N)

4. (5 pts) It is possible to sort in linear time in some special cases. For example, the counting sort works with two extra restrictions on the input. Discuss two restrictions imposed on the input of Counting-sort.

   The two restrictions on the input of Counting-sort are that it must be A) The range of the inputs has to be less than the number of integers (M) and B) The range of integers must be positive (range is from 0 to M)