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Section: 01

Homework: 1

Question 1:

a)

We need to find c and no such that:

$$3n^3+4n^2+2n<=cn^3$$
 for all $N=N_0$

Divide both sides by n^3 , getting

 $3+\frac{C}{4}+\frac{2}{n^2}\leq C$ for all $n\geq n_0$

If we choose no equal to 1 , then we need a value such that:

 $3+4+2\leq C$

We can set c equal to 1 . Now we have

 $3n^3+4n^2+2n\leq 1$ or all $n\geq 1$, the equation applies.

b)

Part 1:

Using repeated subtition method, find
$$\theta$$
 of recorrence relation
$$T(n) = T(n-1) + n^{2}, T(1) = 1$$

$$= t(n-2) + (n-1)^{2} + n^{2}$$

$$= t(n-3) + (n-2)^{2} + (n-1)^{2} + n^{2}$$

$$\vdots$$

$$T(n) = T(n-1) + (n-1)^{2} + (n-1)^{2} + \dots + (n-1)^{2} + n^{2}$$

$$\sum_{k=1}^{n} k^{2} = 1 + (n+2) + \dots + n^{2} = \underbrace{O(n+1)(2n+1)}_{6} = \underbrace{O(n^{3})}_{6}$$

Part 2:

$$T(n) = 2T(\frac{1}{2}) + \frac{1}{2}, T(1) = 1$$

$$= 2(2T(\frac{1}{4}) + \frac{1}{4}) + \frac{1}{2} = 4T(\frac{1}{4}) + 2\frac{1}{2}$$

$$= 4(2T(\frac{1}{2}) + \frac{1}{8}) + 2\frac{1}{2} = 8T(\frac{1}{2}) + 3\frac{1}{2}$$

$$T(n) = 2^{k}.T(\frac{1}{2}) + \frac{1}{2}$$

c)

Selection Sort

[21, 9, 58, 28, 36, 18, 27, 19, 4, 25 \rightarrow min [0], max [9] in Leter,

4, [9, 58, 28, 36, 18, 27, 19, 21, 25 \rightarrow min [0], max [9] in Leter,

4, [9, 58, 28, 36, 18, 27, 19, 21, 25 \rightarrow [2], [9]

4, 9, [8] 28, 36, 58, 27, 19, 21, 25 \rightarrow [3], [9]

4, 9, 18, [9, 36, 58, 27, 28, 21, 25 \rightarrow [4], [9]

4, 9, 18, 19, [21, 58, 27, 28, 36, 58 \lor array is sorted

4, 9, 18, 19, 21, 25, 27, 28, 36, 58 \lor array is sorted

```
58, 28, 36, 18, 27, 19, 4, 25
     28,36,18,27,19,4,25 cmove
          ,18,27,19,4,25 6 move
           ,18,27,19,4,25 & move
         18,58,27,19,4,25
           6,58,27,19,4,25
         36, 58, 27, 19, 4, 25 € move 18
         36, 58, 27, 19, 4, 25 + nove 19
         28,36,58,19,4,25 € move 25
    21, 27, 28, 36, 58, 4, 25 ← more 31
8, 19, 21, 22, 28, 56, 58, 25 c move 42
 , 19, 21, 25, 27, 28, 36, 58 € move 47
      21, 25, 27, 28, 36, 58
```

Question 2:

Displaying bubble, merge and quick sort according to given array:

```
Displaying bubble sort:
1: 12 2: 23 3: 24 4: 25 5: 26 6: 27 7: 29 8: 31 9: 32 10: 33 11: 35 12: 37 13: 38 14: 40 15: 56 16: 79 comp count 114 move count 204 Displaying merge sort:
1: 12 2: 23 3: 24 4: 25 5: 26 6: 27 7: 29 8: 31 9: 32 10: 33 11: 35 12: 37 13: 38 14: 40 15: 56 16: 79 comp count 46 move count 128 Displaying quick sort:
1: 12 2: 23 3: 24 4: 25 5: 26 6: 27 7: 29 8: 31 9: 32 10: 33 11: 35 12: 37 13: 38 14: 40 15: 56 16: 79 comp count 48 move count 128 Displaying quick sort:
1: 12 2: 23 3: 24 4: 25 5: 26 6: 27 7: 29 8: 31 9: 32 10: 33 11: 35 12: 37 13: 38 14: 40 15: 56 16: 79 comp count 48 move count 114
```

Displaying analysis of random arrays:

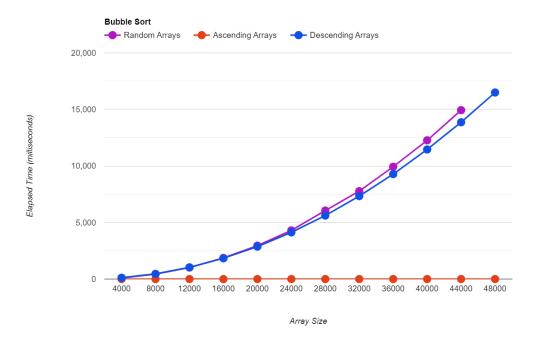
	RANDON	1 ARRAY	ANALYSIS	
Analysis of	Bubble Sort			
	-1	Time	countComp	countMove
4000	96.593 ms 436.01 ms 1022.39 ms 1865.33 ms 2950.96 ms 4302.14 ms 6054.89 ms		7992540	countMove 12109203
8000	436.01 ms		31992840	
12000	1022.39 ms		71988114	108283200
16000	1865.33 ms		127991405	
20000	2950.96 ms		199988047	
24000	4302 14 ms		287947245	
28000	6054.89 ms		391962780	
32000	7770.24 ms		511918659	
36000	9932.02 ms			978585090
40000	12266.7 ms			1195805859
44000	14932.9 ms		967963635	
48000	18094.8 ms		1151955497	
40000	10054.0 1115		1131333437	1/33134//4
Analysis of	Morgo Cort			
Array Size	Flanced	Time	countComp	countMove
4000	1.17 ms	i uiic	countComp 42814	95808
4000	2.465 ms		93598	
8000 12000	2.400 1113		147672	20/010
	3.831 ms 5.219 ms			327232
16000			203274	
20000	6.714 ms		260980	
24000	8.146 ms		319333	
28000	9.621 ms		378722	
32000	11.108 ms		438534	
36000	12.688 ms		499952	
40000	14.166 ms		561763	
44000	15.804 ms		624280	
48000	17.252 ms		686837	1500928
A	out also caret			
Analysis of	Quick Sort	Ti		
Array Size	Etapsed	rume	countComp	countMove
4000	0.924 ms		54288	
8000	2.032 ms		121221	208865
12000	3.045 ms		189110	288850
16000	4.28 ms		272837	399132
20000	5.385 ms		328151	510914
24000	6.875 ms		415667	720232
28000	8.389 ms		551606	878418
32000	9.287 ms		584417	952885
36000	10.214 ms		625624	994649
40000	11.818 ms		706456	1189924
44000	13.022 ms		802702	1320124
48000	14.649 ms		879954	1556457

Analysis of Bubble Sort Array Size		ACCEA	IDTNIC	ADDAW	ANIALVETE	
Array Size Elapsed Time countComp 0 0.023 ms 3999 0 0 8000 0.045 ms 7999 0 0 12000 0.067 ms 11999 0 0 16000 0.068 ms 15999 0 0 0.0000 0.109 ms 19999 0 0 0.20000 0.109 ms 19999 0 0 0.24000 0.131 ms 23999 0 0 0.24000 0.152 ms 27999 0 0 0.25000 0.174 ms 31999 0 0 0.25000 0.174 ms 31999 0 0 0.25000 0.175 ms 35999 0 0 0.0000 0.195 ms 35999 0 0 0.0000 0.218 ms 39999 0 0 0.261 ms 39999 0 0 0.261 ms 43999 0 0 0 0.261 ms 43999 0 0 0 0.261 ms 43999 0 0 0 0	Apolyoic of			ARRAY	ANALYSIS	
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12000	8000	0.025 ms				
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44000 4589.02 ms 967978000 175996	44000				967978000	
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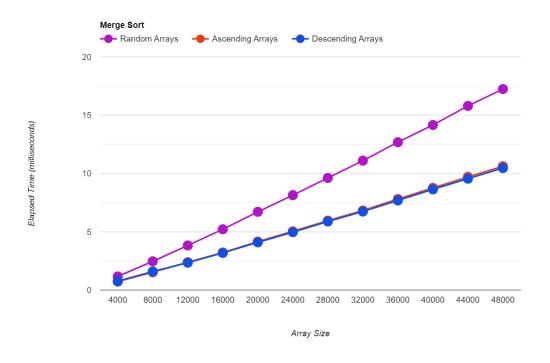
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24000 4126.63 ms 287988000 863956029	5
28000 5615.78 ms 391986000 117594901	
32000 7333.9 ms 511984000 1535941572	9
36000 9280.43 ms 647982000 1943933820	5
40000 11456.5 ms 799980000 2399926743	3
44000 13861.2 ms 967978000 2903919318	
48000 16495.2 ms 1151976000 3455911824	
Analysis of Merge Sort	
Array Size Elapsed Time countComp countMove	9
4000 0.763 ms 23728 95800	
8000 1.598 ms 51456 207610	
12000 2.351 ms 79312 32723	
16000 3.187 ms 110912 44723	
20000 4.097 ms 139216 57446	
24000 4.971 ms 170624 702464	
28000 5.885 ms 202512 830464	
32000 6.74 ms 237824 958464	
36000 7.691 ms 267280 1092928	
40000 8.642 ms 298432 1228928	
44000 9.559 ms 330416 1364928	
48000 10.472 ms 365248 1500928	
10.172 113 303240 1300320	
Analysis of Quick Sort	
Array Size Elapsed Time countComp countMove	2
4000 67.254 ms 7558735 11355732	
8000 269.479 ms 30343610 45550986	
12000 604.945 ms 68177652 102319613	
16000 1075.42 ms 121274559 181982830	
20000 1677.55 ms 189176645 283853688	
24000 2422.58 ms 273211791 409924273	
28000 3296.36 ms 371783811 557799918	
32000 4309.15 ms 486134210 72934354:	
36000 5447.39 ms 614521075 921941449	
40000 6717.17 ms 757789682 1136861543	
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Question 3:

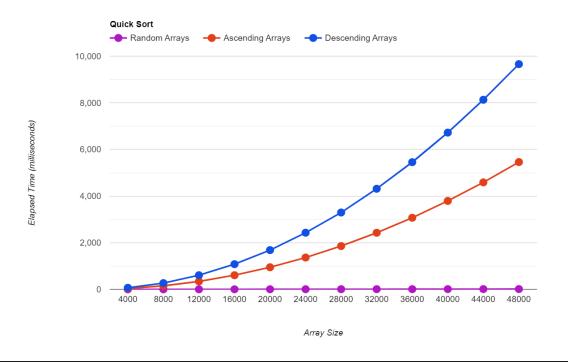
Bubble Sort Comparison



Merge Sort Comparison



Quick Sort Comparison



Bubble Sort: Bubble sort's best case is O(n) and worst case is $O(n^2)$. It is clearly observable that this theorem is true in my experiment. Best case scenario (already sorted) runs with O(n) time complexity with no moves and worst and average case scenarios runs with $O(n^2)$ time complexity.

Merge Sort: Merge sort's time complexity is O(n*logn) for all cases. Theoretically time complexities of all cases are the same. The results I found are a proof for that theorem. There is no notable difference between random, ascending and descending arrays.

Quick Sort: Quick sort's time complexity is $O(n^*logn)$ for average case and $O(n^2)$ for worst case. When array is descending, time needed for the function is maximum in my experiment. The experiment and theorem give similar results.

General Observation: Due to its rapidity, determining its duration was problematic because the calculations used to determine its lifetime were not very precise, and the data occasionally fluctuated. Also, random arrays some array random every time. Therefore, duration changes from run to run. For accurate results, we need to test the program more.