CHAPTER : 5

SORTING

STUDY NOTES

- The process of ordering or arranging a given collection of elements in some particular order is known as Sorting.
- In computer science, sorting is an important area of study. Several sorting algorithms have been developed and analysed from their performance.

Bubble Sort:

- Bubble sort sorts a given list of elements by simply repeatedly comparing the adjacent elements and changing their position with each other if they are not found to be in order.
- Every iteration through each element of the list is called a "pass".
- For a list of size n, a total on n-1 passes are made to sort it.
- The largest element of the element is found and placed in the right position or 'bubbled up'.
- The once sorted element is not considered in the remaining passes therefore the size of the list is reduced in successive passes.

Selection Sort:

- To sort a list having n elements, the selection sort makes (n-1) number of passes.
- The list is considered to be divided into two lists -- the left list that has sorted elements, and the right list that has unsorted elements.
  - ❖ Initially, the left list is empty, and all the elements are in the right list.
  - ❖ In the first pass after traversing through all the elements the smallest element is identified and is swapped with the leftmost element of the unsorted list.
  - ❖ This element is not considered any further for sorting.
- The process continues till the list is sorted.
- Selection sort makes n-1 passes to sort a list of size n.

Insertion Sort:

- In Insertion sort, the list is divided into two parts - one of sorted elements and another of unsorted elements.
- Every element of the unsorted list is one by one evaluated and is inserted into the sorted list at its correct position.
- To find the position where the unsorted element should be inserted, the sorted list is traversed from the backward direction in each pass.

Time Complexity Of Algorithms:

- In the real-world applications, we use sorting algorithms to work on huge data sets.
- Total time utilisation on implementation of an algorithm becomes significant.
- It is important to consider the time complexity of an algorithm in order to use it in an application.

QUESTION BANK

MULTIPLE CHOICE QUESTIONS

1. The process of arranging a given collection of elements in some particular order is known as:
(a) Stacking (b) Sorting (c) Searching (d) Queueing

2. In sorting algorithm, every iteration through each element is known as _____.
(a) Continue (b) Iteration (c) Pass (d) Traversal

3. A list has 12 elements. How many passes will a bubble sort algorithm make to sort the list?
(a) 12 (b) 11 (c) 6 (d) 7

4. Which sorting technique sorts a given list of elements by repeatedly comparing the adjacent elements and swapping them if they are ordered?
(a) Bubble (b) Insertion (c) Selection (d) Sorting

5. Once an element is bubbled up it is:
(a) Not considered for more passes (b) Used in every pass
(c) Stored in stack (d) Stored in register

6. What is true for bubble sort?
(a) It can detect if the input is already sorted (b) It saves times
(c) It consumes less memory (d) It compares adjacent elements

7. How many loops does a bubble sort algorithm have?
(a) 2 nested (b) One (c) Three nested (d) 2 independent

8. A list has 6 elements. What would be the maximum number of comparisons made?
(a) 15 (b) 12 (c) 6 (d) 3

9. What are the best and worst time complexity for bubble sort?
(a) Best: O(n) , worst($O(n^2)$) (b) Best: $O(n^2)$, worst($O(n^2)$)
(c) Best: logn , worst(O(n)) (d) Best: nlogn, logn

10. Which of the following is true for bubble sort of 16, 30, 14, 19?
(a) 16, 30, 14, 19 – 16, 30, 19, 14 – 30,19, 16, 14 (b) 16, 14, 19, 30 – 16, 19, 14, 30 – 19, 16, 14, 30
(c) 30, 19, 16, 14 – 30, 19, 16, 14 – 30, 19, 16, 14 (d) 16, 14, 30 ,19 – 16, 14, 19, 30 – 14, 16, 19, 30

11. Which of the following is not true for bubble sort and selection sort?
(a) Bubble sort is exchanging method and selection sort is selection method
(b) Bubble sort is more efficient than selection sort
(c) Bubble sort makes a greater number of comparisons as compared to selection sort
(d) Bubble sort time complexity for worst case is O(n2)

12. Selection sort maintains two lists:
(a) One empty and one full (b) One sorted and one unsorted
(c) Two lists of equal length (d) Dividing the list to be sorted from the centre

13. The biggest advantage of selection sort is:
(a) It is faster than bubble sort (b) It is scalable
(c) It does not require additional storage (d) It can sort n elements in n/2 passes

14. Average case complexity of selection sort is $O(n^2)$ because:
(a) It is insensitive to the input
(b) This algorithm behaves like the entire array is not sorted
(c) All of the above
(d) None of the above

15. _____ is an algorithm that requires minimum number of swaps.
(a) Insertion sort (b) Quick sort (c) Heap sort (d) Selection sort

16. How many for loops does selection sort use?
(a) 2 nested (b) One (c) Three nested (d) 2 independent

17. How many swaps does selection sort perform in worst case?
(a) N-1 (b) N*(N-1)/2 (c) N! (d) N2

18. In which of the following scenarios will you use a selection sort?
(a) When you have to sort small number of large values
(b) When you have to sort large number of small values
(c) When the list is already sorted
(d) For sorting huge files

19. Bubble sort and selection sort are in place sorting algorithm. This means that:
(a) The input is already sorted (b) Requires O(1) memory to create auxiliary location
(c) Requires additional storage (d) All of the these

20. Bubble sort is the simplest sorting algorithm that works by:
(a) Repeatedly swapping the adjacent elements in case they are unordered in n-1 passes
(b) Divide and conquer approach
(c) Repeatedly shifting the lowest value to the left of the list
(d) Repeatedly shifting the highest value to the left of the list

21. In a sorting algorithm, the smallest element is selected from the unsorted array and swapped with the leftmost element and not considered for further passes. The process continues for the next element in the unsorted array till the list is sorted. Which algorithm are we referring to?
(a) Insertion sort (b) Quick sort (c) Heap sort (d) Selection sort

22. A list [7,11,3,10,17,23,1,4,21,5] will look as follows:
(a) 7,3,10,11,17,1,4,21,5,23 (b) 3,7,10,11,1,4,17,5,21,23
(c) 3,7,10,1,4,11,5,17,21,23 (d) 1,3,4,5,7,10,11,17,21,23

23. How many swaps required to swap [60,41,20,7] using bubble sort?
(a) 6 (b) 8 (c) 10 (d) 4

24. How many swaps required to swap [60,41,20,7] using selection sort?
(a) 2 (b) 7 (c) 5 (d) 4

25. What will be the number of passes needed to sort a list of five elements?
(a) 5 (b) 6 (c) 7 (d) 8

26. What will be the state of the list [14,12,16,6,3,10] at the end of third pass using insertion sort?
(a) 14,12,16,6,3,10 (b) 12,14,16,6,3,10
(c) 6,12,14,16,3,10 (d) 12,14,16,6,3,10

27. Arranging a pack of cards is an example of:
(a) Insertion sort (b) Merge sort (c) Quick sort (d) Normal sort

28. Bubble sort, insertion sort and selection sort are implemented using:
(a) For (b) If (c) Try (d) finally

29. In insertion sort average number of comparisons required to place the 7^{th} element into the correct position is:
(a) 2 (b) 7 (c) 4 (d) 9

30. What will be the number of swapping are involved to swap [8, 22, 7, 9, 31, 5, 13] in ascending order?
(a) 5 (b) 9 (c) 10 (d) 16

31. How would [34, 8, 64, 51, 32, 21] look like after second pass of insertion sort?
(a) 34, 8, 64, 51, 32, 21 (b) 8, 34, 64, 51, 32, 21 (c) 34, 8, 51, 64, 32, 21 (d) 34, 8, 64, 51, 21, 32

32. What would be the running time of an insertion sort for a pre-sorted list?
(a) $O(n^2)$ (b) O(nlogn) (c) O(n) (d) None of these

33. Which algorithm is similar to placing cards at the right position while playing cards?
(a) Bubble sort (b) Selection sort (c) Insertion sort (d) Merge sort

34. Any algorithm that does not have any loop will have time complexity as:
(a) 1 (b) N (c) N^2 (d) None of these

35. Any algorithm that has a loop (usually 1 to n) will have the time complexity of:
(a) 1 (b) N (c) N^2 (d) None of these

36. A loop within a loop (nested loop) will have the time complexity of:
(a) 1 (b) N (c) N^2 (d) None of these

37. Algorithm with _____ loops are also called quadratic time algorithm.
(a) Nested (b) For (c) While (d) None of these

38. When there is a nested loop and also a single loop, the time complexity will be:
(a) 1 (b) N (c) N^2 (d) None of these

INPUT TEXT BASED MCQs

Read the following passage and answer the following questions (39 to 42).

Bubble sort sorts a given list of elements by repeatedly comparing the adjacent elements and swapping them if they are unordered. Swapping two elements means changing their positions with each other. In algorithm,every iteration through each element of a list is called apass. For a list with n elements, the bubble sort makes total of n – 1 passes to sort the list. In each pass, the required pairs of adjacent elements of the list will be compared. In order to arrange elements in ascending order, the largest element is identified after each passand placed at the correct position in the list.

39. "the largest element is identified after each pass and placed at the correct position in the list." What is this called?
(a) Bubbling (b) Bubble up (c) Bubble down (d) Bubbled up

40. Amongst bubble sort, selection sort and insertion sort, bubble sort is the:
(a) Fastest (b) Slowest (c) Most efficient (d) None of these

41. Bubble sort alternately compares and swaps adjacent elements in every pass.
(a) True (b) False

42. What is not true for bubble sort?
(a) Simplest sorting algorithm (b) In place sorting
(c) Most efficient (d) Stable

ANSWERS

Multiple Choice Questions

1. (b)	2. (b)	3. (b)	4. (a)	5. (a)	6. (b)	7. (a)	8. (a)	9. (a)	10. (d)
11. (b)	12. (b)	13. (c)	14. (b)	15. (d)	16. (a)	17. (a)	18. (a)	19. (b)	20. (d)
21. (c)	22. (c)	23. (a)	24. (a)	25. (a)	26. (c)	27. (a)	28. (a)	29. (c)	30. (b)
31. (b)	32. (c)	33. (c)	34. (a)	35. (b)	36. (c)	37. (a)	38. (c)		

Input Text Based MCQs

39. (c)	40. (b)	41. (b)	42. (c)

HINTS/EXPLANATION

1. The process of arranging a given collection of elements in some particular order is known as sorting.
3. In bubble sort, n-1 passes are made to sort the list so for 12 elements , there will be 11 passes.
4. Bubble sort technique sorts a given list of elements by repeatedly comparing the adjacent elements and swapping them if they are ordered.

6. Bubble sort is a time consuming algorithm.

8. Maximum number of passes in bubble sort = n(n-1)/2, n = 6. Therefore, maximum number of passes = 6*(6-1)/2 = 6 * 5/2 = 30/2 =15.

10. 16, 14, 30 ,19 – 16, 14, 19, 30 – 14, 16, 19, 30 displays bubble sort in ascending order.

12. Selection sort maintains two lists one sorted and one unsorted.

15. Selection sort is an in place algorithm that requires minimum number of swaps because in selection sort we repeatedly choose the smallest element and put it in the right place hence the total number of swaps are n-1 in worst case. Hence, selection sort makes the minimum number of swaps as compared to other algorithms.

16. Selection sort uses two nested loops.

18. Selection sort is ideal for small number of elements, value of element does not matter.

19. Bubble sort and selection sort are in place sorting algorithm. This means that it requires O(1) memory to create auxiliary location.

24. For selection sort, there are 2 swaps:

    63,42,21,9

    1st swap: 9,42,21,,63

    2nd swap: 9,21,42,63

25. If total number of elements in list is 6 then, it would require 6-1 = 5 passes insertion sort.

26. given list: = [14,12,16,6,3,10]

    End of 1st pass: 12,14,16,6,3,10

    End of 2nd pass: 12,14,16,6,3,10

    End of 3rd pass: 6,12,14,16,3,10

27. Arranging pack of cards is an example of insertion sort.

29. Average number of comparisons required to place the k^{th} element into its correct position is (k+1)/2. Here, k =7. Therefore, total number of comparisons = (7+1)/2 = 8/2 =4.

31. Given array: 34,8,64,51,32,21

    After first pass:

    8,34,64,51,32,21

    After second pass:

    8,34,64,51,32,21

33. Insertion Sort, because it places the element of a list ati ts suitable place in each pass.

34. Any algorithm that does not have any loop will have time complexity as 1.

35. Any algorithm that has a loop (usually 1 to n) will have the time complexity of N. This is because the loop will execute N number of times.

36. Nested loops have time complexity of n2.

37. Algorithms with nested loops are called quadratic time algorithms.

38. When there is a nested loop and a single loop, the time complexity is estimated on the basis of nested loop only.