CHAPTER : 6

SEARCHING

STUDY NOTES

- Every computer is capable of storing a lot of data which can be retrieved by the user as and when there is a requirement.
- A specific item can be located in a collection of items using searching techniques.
- A searching technique can be used to determine whether an element exist in a collection or not. If the element is existing then its location can be identified.
- There are different types of searching algorithms available and one has to decide which algorithm is most suited for his data.

Linear Search:

- Linear search is the most basic and simplest search method.
- Linear search algorithm compares every element of a given list with the item to be searched.
- Linear search is also known as Sequential or Serial search.
- In a list of n elements, if the key is not present in the list or is placed at the end then the linear search algorithm will have to make n comparisons.

Binary Search:

- Binary search is conducted on a sorted list.
- If the list provided has elements arranged in order, then we can search more efficiently using binary search as compared to Linear search.
- The first comparison of the key is made with the element in the middle of the list.
- Binary search algorithm involves following steps:
  - ❖ It takes a sorted/ordered list.
  - ❖ Midpoint of the list is calculated.
  - ❖ The key is compared to the element in the middle.
  - ❖ If the key matches, the program ends.
  - ❖ If the key does not match then the algorithm checks if the key is greater than the key:
    - ■ If yes, then it continues repeating the search in similar manner in the first half of the list.
    - ■ If no, then it continues repeating the search in similar manner in the second half of the list.

Hashing:

- Hashing is a searching technique which allows you to find if a key exists in a sequence in just one step.
- It makes searching operation efficient.
- It has a hash function that generates index value for each element.
- The hash function works with remainder method to generate a hash value.
- Hash value, h(element) = element%size(hash table).
- Two elements having the same hash value will create a problematic condition called collision.
- Collision is handled by collision resolution.

QUESTION BANK

MULTIPLE CHOICE QUESTIONS

1. Techniques used to search the location of a particular information on a computer is known as:
   (a) Stacking (b) Searching (c) Sorting (d) Garbage Collection
2. Item to be searched is referred to as:
   (a) Value (b) Element (c) Key (d) Item
3. The most fundamental and simplest search method is known as:
   (a) Binary Search (b) Bubble sort (c) Linear Search (d) Insertion sort
4. Linear search is also known as:
   (a) Binary search (b) Sequential search (c) Serial search (d) Both (b) and (c)
5. How many comparisons of Linear search will be required to search for key = 17 in the list [8,-4,7,17,0,12,56]?
   (a) 4 (b) 7 (c) 8 (d) 5
6. If the key to be searched is the last element in the list, then linear search algorithm will make how many comparisons?
   (a) n(n+1)/2 (b) n-1 (c) n (d) n+1
7. In the list L = [78,65,43,24,9,6,18,16,3], determine the number of comparisons linear search takes to search for key = 3.
   (a) 10 (b) 9 (c) 4 (d) 8
8. In which of the following scenarios would you prefer to use a Linear search algorithm?
   (a) When you have to search through an ordered data set.
   (b) When you have to search through an unordered data set.
   (c) When you are dealing with a small data set.
   (d) When you are dealing with a huge data set.
9. In a list [3,7,4,5,8,2,9], in which call will element 2 be found?
   (a) 1^{st} call (b) 6^{th} call (c) 3^{rd} call (d) 7^{th} call
10. If the key to be searched is not in the list, then linear search algorithm will make how many comparisons?
    (a) n(n+1)/2 (b) n-1/2 (c) n (d) n2
11. A searching technique that quickly orders elements in the list to quickly search for keys is known as:
    (a) Linear Search (b) Stacking (c) Hashing (d) Binary search
12. Given list [45,76,87,90,93,99,105] and key = 99; what are the mid values in the first and second iteration?
    (a) 90 and 76 (b) 90 and 99 (c) 90 and 87 (d) 90 and 93
13. Binary search makes use of:
    (a) Divide and Conquer method (b) Linear Search
    (c) Bubble Sorting (d) Stacking
14. Consider the list [17, 8, -4, 7, 0, 2,19]. How many iterations are required to find key 7 using linear search?
    (a) 1 (b) 2 (c) 4 (d) 3
15. For 9 elements in a list, binary search will start from element at:
    (a) 0 (b) 5 (c) 9 (d) 4
16. In binary search, after every pass:
    (a) The search area is reduced by half (b) The algorithm changes
    (c) Sorting is done calling the sort() function (d) Both algorithm and search are changes

17. When we say that in binary search with every pass the search area is reduced by half means:
(a) Half of the list is deleted
(b) One half of the same list is considered for search
(c) A new list is created and elements for next search are moved into it
(d) Search is conducted by slicing the list

18. Binary search algorithm is also known as:
(a) Logarithmic search algorithm
(b) Serial search algorithm
(c) Sequential search algorithm
(d) Half-interval search algorithm

19. How many iterations will be required if the key to be found is in the middle of the list of size N?
(a) 1 (b) N (c) N-1 (d) (N-1)/2

20. Which is the most preferred technique used for finding a value in a list?
(a) Bubble sort (b) Binary search (c) Insertion sort (d) Linear search

21. Binary search is used for finding element in a:
(a) Sorted list (b) Unsorted list (c) Big lists only (d) Small lists only

22. Determine the number of comparisons required in list [-4, 0, 2,7, 8, 17, 19] to search for – 4.
(a) 1 (b) 2 (c) 3 (d) 4

23. The worst case in Linear search is:
(a) When the key is in the middle of the list
(b) When the key is at the end of the list
(c) When the key is not present
(d) When the key is at the end or it is not present.

24. An average case occurs in linear search algorithm when:
(a) When the key is in the middle of the list
(b) When the key is at the end of the list
(c) When the key is not present
(d) When the key is at the end or it is not present.

25. What is the limitation of a binary search algorithm?
(a) Usage of sorted list.
(b) Requirement of sorted list is expensive.
(c) There must be a mechanism to access the middle element directly.
(d) Not efficient when data element is more than 100.

26. Locating a particular element called key in a collection of elements is known as:
(a) Sorting (b) Testing (c) Debugging (d) Searching

27. What is not true for linear search?
(a) Sequentially compares key with elements in list.
(b) Does not skip any element of the list.
(c) Time taken to conduct search is inversely proportional to size of the list.
(d) Slow and time consuming algorithm.

28. A modified binary search is used when one is:
(a) Shuffling cards
(b) Stacking plates
(c) Data compression code
(d) Looking for data in telephone directory

29. Searching operation is made efficient by:
(a) Searching (b) Sorting (c) Stacking (d) Hashing

30. A hash function is used to:
(a) Create encrypted values for data
(b) Displays values as hash
(c) Calculate index for each element
(d) Conducts linear search

31. A hash function creates hash values using:
(a) Sorting (b) Searching (c) Remainder method (d) Divide and conquer

32. What is true for binary search comparisons?
(a) Comparisons that do not find the key give us an idea about the location of the key.
(b) Comparisons reveal whether the key exists before or after the current middle position.
(c) Information provided by the comparisons can be used to narrow down or reduce searching efforts.
(d) All of the above

33. Hash function cannot be based on:
(a) Modulo division (b) Boundary folding (c) Linear search (d) Radix transformation

34. In an event of collision, the process of identifying a slot for the second and further items in a hash table is known as:
(a) Restriction resolution (b) Hash resolution (c) Collision resolution (d) Resolution

35. Two elements mapping to the same slot in the hash table is known as :
(a) Conflict (b) Collision (c) (a) and (b) (d) None of these

36. Hash function requires minimum three comparisons to find out presence or absence of a key.
(a) True (b) False

37. In the given list 1,2,3,5,6,4. Given that number 13 is to be searched. In which call will it be known that 13 does not exist. Search is conducted using Linear search.
(a) 3^{rd} call (b) 5^{th} call (c) 6^{th} call (d) 1^{st} call

38. O(n) is the best case runtime for Linear search algorithm on an ordered set of elements.
(a) True (b) False

39. Element in an unordered list cannot be searched using:
(a) Linear Search (b) Binary Search
(c) Linear and Binary search (d) None of these

40. O(n) is the worst case runtime for Linear search algorithm.
(a) True (b) False

41. The biggest disadvantage of a Linear search is that:
(a) It requires more space (b) It is difficult to understand
(c) Difficult to implement (d) Less efficient compared to other search algorithms.

42. Linear search is best for performing search on unordered list of few elements.
(a) True (b) False

43. Binary search can be performed only on ordered lists
(a) True (b) False

44. 88 can be found in [5,6,77,88,99] in _____ iterations using binary search.
(a) 1 (b) 3 (c) 2 (d) 4

45. Binary search algorithm changes the list.
(a) True (b) False

46. In each iteration of binary search the search area is reduced.
(a) True (b) False

47. Linear search is time consuming if applied on big lists.
(a) True (b) False

48. Binary list divides a list into half then sorts that half to conduct search.
(a) True (b) False

49. Linear search works on the principle of divide and rule.
(a) True (b) False

50. Binary search works on the principle of divide and rule.
(a) True (b) False

INPUT TEXT BASED MCQs

Read the following passage and answer the following questions (51 to 54).

Hashing is a technique which can be used to know the presence of a key in a list in just one step. The idea is if we already know the value at every index position in alist, it would require only a single comparison to check the presence or absence of a key in that list. Hashing makes searching operations very efficient. A formula called hash function is used to calculate the value at an index in the list.

51. The hash function takes elements of a list one by one and generates an index value for every element. This will generate a new list :
(a) Hashing (b) Hash list (c) Hash table (d) Hash tuple

52. A simple hash function that works with numeric values is known as the :
(a) Dividing method (b) Remainder method (c) Folding method (d) Hashing method

53. The remainder method takes an element from a list and divides it by the size of the hash table.
(a) True (b) False

54. The remainder generated from remainder method is called:
(a) hash value (b) remainder value (c) h element (d) hvalue

ANSWERS

Multiple Choice Questions

1. (b)	2. (c)	3. (c)	4. (d)	5. (a)	6. (c)	7. (b)	8. (c)	9. (b)	10. (c)
11. (c)	12. (b)	13. (a)	14. (c)	15. (d)	16. (a)	17. (b)	18. (d)	19. (a)	20. (d)
21. (a)	22. (a)	23. (d)	24. (a)	25. (a)	26. (d)	27. (c)	28. (d)	29. (d)	30. (c)
31. (c)	32. (d)	33. (c)	34. (c)	35. (c)	36. (b)	37. (c)	38. (b)	39. (b)	40. (a)
41. (d)	42. (a)	43. (a)	44. (c)	45. (b)	46. (a)	47. (a)	48. (b)	49. (b)	50. (a)

Input Text Based MCQs

51. (c)	52. (b)	53. (a)	54. (a)

HINTS/EXPLANATION

1. Locating a particular element in a collection is known as Searching. Therefore, technique used to search the location of particular information is also referred to as Searching.
2. Item to be searched using searching algorithm is known as a key.
3. Linear search is the most fundamental and simplest search method.
4. Linear search is also known as sequential or Serial search.
5. List [8,-4,7,17,0,12,56] has 7 elements and in case of Linear search algorithm the key is one by one sequentially compared with each element in the list. Since key '17' is place at index 3 which is actually the 4^{th} position of the list, a match would be found in 4 comparisons. Hence the answer is 4.
7. Linear search algorithm searches sequentially mapping the key with each element in the list. the list L = [78,65,43,24,9,6,18,16,3] has 9 elements and the key 3 is the last element in the list. Therefore, the search will end at the 9th comparison.
8. We prefer to use linear search algorithm when the dataset is of small size. It does not matter if the dataset is ordered or unordered because the algorithm will conduct search sequentially. Linear search is not ideal for large data set. Imagine if there are 100 elements in a list and it does not have the key then the algorithm will conduct n number of searches.

11. The searching technique that quickly orders elements in the list to quickly search for keys is known as Binary search. It sorts the elements. The first comparison of the key made with the element in the middle of the list. This could result in three scenarios:
    (i) The key is present in the middle and a match is found in one go.
    (ii) The key is smaller than the element in the middle.
    (iii) The key is bigger than the element in the middle.

    Since the list is sorted it is obvious that:
    (i) If the key is smaller than the middle element then it has to exist in the first half of the list and second half of the key can be ignored. We proceed searching the first half with the same divide and conquer method.
    (ii) If the key is bigger than the middle element then it has to exist in the second half of the list and second half can be ignored. We proceed searching the Second half with the same divide and conquer method.

12. midpoint = (first + last)//2
    For list [45,76,87,90,93,99,105]
    First = 0, last = 7
    Midpoint = (0+7)//2 = 3
    Element at index 3 = 90
    Key = 99
    99> 90; Key is greater than the midpoint
    First of the list can be ignored.
    List under consideration[93,99,105], where 93 is at index 4 or original list
    First = 4
    Last = 6
    Midpoint = (4+6)//2
    = 10//2
    = 5
    Midpoint for the second iteration is index 5, i.e. 99.
    Therefore, midpoint for first iteration is 90 and mid-point for second iteration is 99.

13. Binary search uses divide and conquer method.

14. Given list = [17, 8, -4, 7, 0, 2,19]
    First = 0
    Last = 6
    Midpoint = (0+6)//2 = 3
    Element at index 3 = 7
    Key = 7
    Therefore, the key is found in the very first iteration.

16. In binary search, after every pass the search area is reduced by half. It starts its search by the element at the middle and then if the key is greater than the number it conducts the search on the right side of the list or else it will search toward the left side.

17. While conducting a binary search one half of the same list is considered for searching.

18. Binary search algorithm is also known as half-interval search algorithm.

20. Out of the given options, binary search is the most preferred technique. It is more efficient than linear search. The other two options bubble sort and insertion sort are sorting algorithms not used for searching.

21. Binary search is used to find values in sorted lists only.

22. Give list = [-4, 0, 2,7, 8, 17, 19]
    Iteration 1: First = 0, last =6

Midpoint = (0+6)//2 = 6//2 = 3, value at index 3 is 7.
-4 <7, so we will consider first half of the list
Iteration 2: First = 0, last = 2
Midpoint = (0+2)//2 = 1, value at index 1 is 0
-4<0, so we will consider left half
Iteration 3: First = 0, last =0
Midpoint = 0//2 = 0
Number at index 0 is -4

23. The worst case scenario in Linear search is when the key is not present or is at the end because in both the cases the algorithm conducts n number of searches, where n is the size of the list.

24. Since, linear search algorithm searches sequentially, the average case is when the key is placed at the centre.

25. Binary search can work efficiently when data element is less than 100 hence, that is not a limitation.

26. Locating a particular element called key in a collection of elements is known as Searching

27. In case of Linear search, time-taken to search the list increases as the size of the list increases.

28. Modified binary search is used while data compression code.

29. Searching operation is efficient in hashing.

30. In hashing, hash function is used to calculate index of each element.

31. A hash function creates hash values using remainder method.

32. All options are true for binary search.

33. Hash function cannot be based on linear search.

34. In an event of collision, the process of identifying a slot for the second and further items in a hash table is known as collision resolution.

35. Two elements mapping to the same slot in the hash table is known as collision.

36. Hash function can find out presence or absence of value in one comparison.

38. O(1) is the best case runtime for Linear search algorithm on an ordered set of elements.

39. Element in an unordered list cannot be searched using binary search.

40. Yes, O(n) is the worst case runtime for Linear search algorithm.

42. Linear search is best for performing search on unordered list of few elements.

43. Binary search can be performed on ordered lists only.

44. 88 will be found in two iterations.

45. Binary search does not change the list.

46. In each iteration of binary search, the search area is reduced.

48. Binary search first sorts the list.

49. Linear search does not work on the principle of divide and conquer.

50. Binary search works on the principle of divide and conquer.