CS & IT ENGINEERING

PYQ SERIES

Algorithms

Lecture No.- 1

By- Dr. Khaleel Khan Sir

Topics to be Covered

Topic ALGORITHMS

Topic : Algorithms 2022 : CS

ISRO PYQ SERIES

#Q. What is the time complexity of the following recursive function :

```
int DoSomething (int n)
{
        if (n <= 2)
        return 1;
else
return (DoSomething (floor(sqrt(n))) + n);
}
```

A $\Theta(n)$

B $\Theta(n\log n)$

C $\Theta(n\log n)$

D $\Theta(\log\log n)$

$$T(n) = c \quad , n \le 2$$
$$= T(\sqrt{n}) + a, \quad n > 2$$

$$T(n) = T(n^{1/2}) + a \quad - (1)$$
$$T(n^{1/2}) = T(n^{1/4}) + a \quad - (2)$$
$$T(n) = T(n^{1/4}) + 2a \quad - (3)$$
$$= T(n^{1/2^2}) + 2a \quad - (3)$$
$$= T(n^{1/2^k}) + k\cdot a \quad - (4)$$
$$= (c + a \cdot \log\log n) = \Theta(\log\log n)$$

$$n^{1/2^k} = 2$$
$$\frac{1}{2^k} \cdot \log n = 1$$
$$2^k = \log n$$
$$k = \log\log n$$

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#Q. The running time of an algorithm T(n), where 'n' is the input size, is given by

$$T(n) = 8T(n/2) + qn, \text{ if } n > 1$$
$$= p, \quad \text{if } n = 1$$

Where p, q are constants. The order of this algorithm is

A. n^2

B. n^n

C. n^3

D. n

$a = 8;\ b = 2;\ f(n) = qn$

Case I: qn is it $O(n^{\log_2 8 - \epsilon})$

$O(n^{3-\epsilon})$ ✓

$\therefore T(n)$ is $O(n^3)$ $\quad \epsilon = 2$

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#Q. An algorithm is made up of two modules M1 and M2. If order of M1 is f(n) and M2 is g(n) then the order of algorithm is

A. Max (f(n), g(n))

B. Min (f(n), g(n))

C. f(n) + g(n)

D. f(n) x g(n)

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#Q. Consider the following C code segment:

```
int Is_Prime (n)
{
    int i, n;
    for (i=2; i<= sqrt(n); i++)
    if (n % i == 0)
    {
        printf ("Not Prime.\n");
        return 0;
    }
    return 1;
}
```

$\sqrt{n}$

1

Let T(n) denote the number of times the for loop is executed by the program on input n. Which of the following is true ?

A. $T(n) = O(\sqrt{n})$ and $T(n) = \Omega(\sqrt{n})$

B. $T(n) = O(\sqrt{n})$ and $T(n) = \Omega(1)$

C. $T(n) = O(n)$ and $T(n) = \Omega(\sqrt{n})$

D. None of these

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#Q. Which of the following algorithm solve the all-pair shortest path problem ?

A. Dijkstra's algorithm

B. Floyd's algorithm

C. Prim's algorithm

D. Warshall's algorithm

#Q. Tile worst case running times of insertion sort, merge sort and quick sort, respectively, are

n^2 $n\log n$ n^2

A $\Theta(n\log n)$, $\Theta(n\log n)$ and $\Theta(n^2)$

B $\Theta(n^2)$, $\Theta(n^2)$ and $\Theta(n\log n)$

C $\Theta(n^2)$, $\Theta(n\log n)$ and $\Theta(n\log n)$

D $\Theta(n^2)$, $\Theta(n\log n)$ and $\Theta(n^2)$

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#Q. Which of the following standard algorithms is not Dynamic programming based?

A. Bellman-ford Algorithm for single source shortest path

B. Floyd Warshall Algorithm for all pairs shortest paths

C. 0-1 Knapsack problem

D. Prim's Minimum Spanning Tree

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#Q. Kadane algorithm is used to find

A. Maximum sum subsequence in an array

B. Maximum sum subarray in an array

C. Maximum product subsequence in an array

D. Maximum product subarray in an array

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#Q. Let G be a graph with n vertices and m edges. What is the tightest upper bound on the running time on Depth First Search of G ? Assume that the graph is represented using adjacency matrix.

A $O(n)$

B $O(m + n)$

C $O(n^2)$

D $O(mn)$

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#Q. Suppose $T(n) = 2T(n/2) + n$, $T(0) = T(1) = 1$
Which one of the following is false ?

Mergesort

Case II : n is $\Theta(n \cdot \log^k n)$

$k = 1$

$\therefore T(n)$ is $\Theta(n\log n)$

A $T(n) = O(n\wedge2)$

B $T(n) = \Theta(n\text{Log}n)$

C $T(n)= \Omega(n^2)$

D $T(n) = O(n\text{Log}n)$

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#Q. Which of the following is an advantage of adjacency list representation over adjacency matrix representation of a graph ?

A In adjacency list representation, space is saved for sparse graphs.

B Deleting a vertex in adjacency list representation is easier than adjacency matrix representation.

C Adding a vertex in adjacency list representation is easier than adjacency matrix representation.

D All of the option

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#Q. What is the running time of the following function (specified as a function of the input value) ?

```
void Function(int n) (
int i=1;
int s=1;
while( s <=n) {
i++;
s= s+i;
}
}
```

'x'

Time: $O(x)$

$i = 1 \quad 2 \quad 3 \quad 4 \quad \cdots\cdots \quad x$

$s = (1)\ (1+2)\ (1+2+3)\ (1+2+3+4)\ \cdots\ (1+2+3+\cdots+x)$

$(1+2+3+\cdots+x) = n$

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

$x^2 + x = 2n$

$x^2 \sim n$

$x \sim \sqrt{n}$

A. $O(n)$

B. $O(n^2)$

C. $O(1)$

D. $O(\sqrt{n})$ ✓

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#Q. 0/1 - Knapsack is a well known problem where, it is desired to get the maximum total profit by placing n items (each item is having some weight and associated profit) into a knapsack of capacity W. The table given below shows the weights and associated profits for 5 items, where one unit of each item is available to you. It is also given that the knapsack capacity W is 8. If the given 0/1 knapsack problem is solved using Dynamic Programming, which one of the following will be maximum earned profit by placing the items into the knapsack of capacity 8.

item #	Weight	Associated Profit
1	1	3
2	2	5
3	4	9
4	5	11
5	8	18

A. 19

B. 18

C. 17

D. 20

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#Q. The Knapsack problem belongs to which domain of problems?

A. Optimization

B. NP complete

C. Linear solution

D. Sorting

#Q. The running time of Quick sort algorithm depends heavily on the selection of:

A. No. of inputs

B. Arrangement of elements in an array

C. Size of elements

D. Pivot Element

2 mins Summary

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Algorithms

Lecture No.- 2

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Recap of Previous Lecture

Topic ALGORITHMS PYQ 01

Topics to be Covered

Topic ALGORITHMS PYQ 02

#Q. Two main measures for the efficiency of an algorithm are:

A Processor and Memory

B Complexity and Capacity

C Time and space

D Data and Space

Topic : Algorithms 2016 : CS

#Q. What is the solution to the recurrence $T(n) = T\left(\frac{n}{2}\right) + n$?

A O (log n)

B O (n)

C O (n logn)

D None of these

$a = 1;\ b = 2;\ f(n) = n$

n is it $O(n^{0-\epsilon})$ ×

n is it $\Omega(n^{0+\epsilon})$ ✓

$a \cdot f(n/b) \le \delta \cdot f(n)$ ✓

$\delta < 1$

$\therefore$ Case-III $\quad T(n)$ is $\Theta(n)$

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#Q. The concept of order Big O is important because:

A. It can be used to decide the best algorithm that solves a given problem

B. It is the lower bound of the growth rate of algorithm

C. It determines the maximum size of a problem that can be solved in a given amount of time

D. Both (A) and (B)

#Q. Two alternative packages A and B are available for processing a database having 10k records. Package A requires 0.0001n2 time units and package B requires l0nlogl0n time units to process n records. What is the smallest value of k for which package B will be preferred over A ?

$0.0001n^2$ "A"

$10 \cdot n \cdot \log_{10} n$ "B"

$n = 10^K$

DB

A 12

B 10

C 6

D 5

$n = 10^K$

$10 \cdot n \cdot \log_{10} n < 10^{-4} n^2$

$10 \cdot \cancel{10^K} \cdot K < 10^{-4} \times 10^{\cancel{2K}}$

$\boxed{K < \frac{10^K}{10^5}}$

K=6

#Q. What is the type of the algorithm used in solving the 4 queens problem?

A Greedy

B Branch and Bound

C Dynamic

D Backtracking

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#Q. Selection sort, quick sort is a stable sorting method.

A. True, True

B. False, False

C. True, False

D. False, True

Topic : Algorithms 2016 : CS

#Q. Which of the following sorting procedures is the slowest?

A. Quick Sort

B. Merge Sort

C. Shell Sort

D. Bubble Sort

Topic : Algorithms 2016 : CS

#Q. The recurrence relation capturing the optimal execution time of the Towers of Hanoi problem with n discs is:

A. $T(n) = 2T(n - 2) + 2$

B. $T(n) = 2T(n/2) + 1$

C. $T(n) = 2T(n - 1) + n$

D. $T(n) = 2T(n - 1) + 1$

Topic : Algorithms 2016 : CS

#Q. Find the odd one out:

A Merge Sort

B TVSP Problem

C Knapsack Problem

D OBST Problem

D.P

#Q. The recurrence relation $T(n) = 7T(n/7) + n$ has the solution:

A. $O(n)$

B. $O(\log n)$

C. $O(n\log(n))$

D. $O(n^2)$

$a = 7;\ b = 7;\ f(n) = n$

n is it $O(n^{1-\epsilon})$ ✗

n is it $\Theta(n^1 \cdot \log^k n)$ ✓

$\Theta(n \cdot \log n)$ ✓

#Q. Consider the algorithm that solves problems of size n by recursively solving two sub problems of size n -1 and then combining the solutions in constant time. Then the running time of the algorithm would be :

$T(n) = 2 \cdot T(n-1) + c$

$O(2^n)$ ✓

A O(n)

B O(logn)

C O(nlogn)

D O($\cancel{n^2}$) 2^n

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#Q. What is the advantage of bubble sort over other sorting techniques?

A It is faster

B Consumes less memory

C Detects whether the input is already sorted

D All of the options

#Q. What is the best case complexity of Quicksort?

A. $O(n \log n)$

B. $O(\log n)$

C. $O(n)$

D. $O(n^2)$

Topic : Algorithms 2019 : CS

#Q. Which of the following techniques deals with sorting the data stored in computer's memory?

A. Distribution sort

B. Internal sort

C. External sort

D. Radix sort

#Q. Which sorting algorithm sorts by moving the current data element past the already sorted values and repeatedly interchange it with the preceding value until it is its correct place ?

A. Insertion sort

B. Internal sort

C. External sort

D. Radix sort

2 mins Summary

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Lecture No.- 3

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Recap of Previous Lecture

Topic ALGORITHMS PYQ 02

Topics to be Covered

Topic ALGORITHMS PYQ 03

Topic : Algorithms 2019 : CS

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Case

#Q. The best running time is defined as/obtained as/by:

A. the least or smallest of all the running times the algorithm takes, on inputs of a particular size.

B. an input that requires maximum computations or resources.

C. averaging the different running times for all inputs of a particular kind.

D. None of the options.

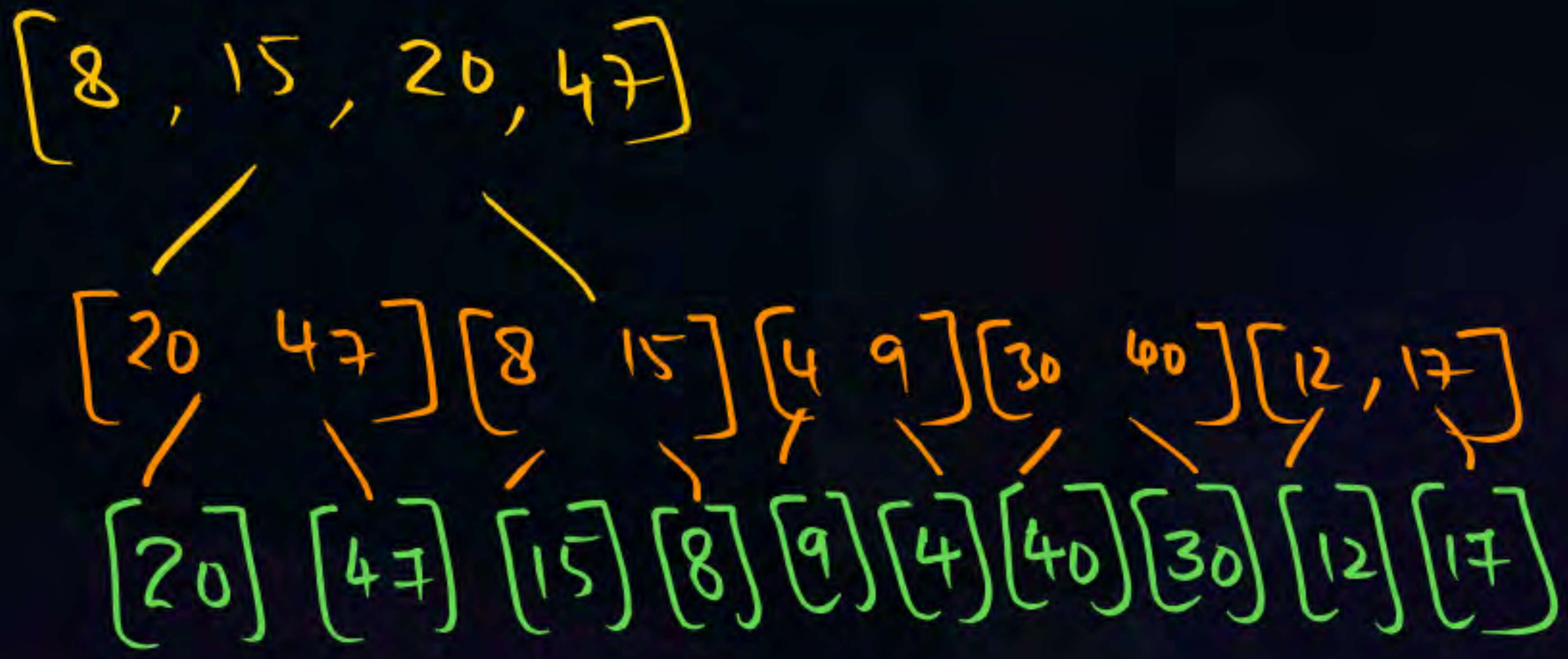
#Q. If one uses straight two-way merge sort algorithm to sort the following elements in ascending order 20, 47, 15, 8, 9, 4, 40 30,12,17 then the order of these element after the second pass of the algorithm is:

A 8, 9, 15, 20, 47, 4, 12,17, 30, 40

B 8, 15, 20, 47, 4, 9, 30, 40, 12,17

C 15, 20, 47, 4, 8, 9, 12, 30, 40,17

D 4, 8, 9, 15, 20, 47, 12, 17, 30, 40



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#Q. What is the product of following matrix using Strassen's matrix multiplication algorithm?

$$A = \begin{bmatrix} 1 & 3 \\ 5 & 7 \end{bmatrix} \quad B = \begin{bmatrix} 8 & 4 \\ 6 & 2 \end{bmatrix}$$

A. $C_{11} = 80; C_{12} = 07; C_{21} = 15; C_{22} = 34$

$c_{11} = 1 \cdot 8 + 18 = 26$

B. $C_{11} = 82; C_{12} = 26; C_{21}\text{-}10; C_{22}\text{-}34$

C. $C_{11} = 15; C_{12} = 07; C_{21} = 80; C_{22} = 34$

D. $C_{11} = 26; C_{12} = 10; C_{21} = 82; C_{22} = 34$

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#Q. In case of the dynamic programming approach the value of an optimal solution is computed in:

A. Top down fashion

B. Bottom up fashion

C. Left to Right fashion

D. Right to Left fashion

#Q. Which of the following is a correct time complexity to solve the 0/1 knapsack problem where n and w represents the number of items and capacity' of knapsack respectively ?

A. $O(n)$

B. $O(w)$

C. $O(nw)$

D. $O(n + w)$

Topic : OS 2019 : CS

#Q. Which of the following is correct recurrence for worst case of Quicksort ?

A $T(n) = T(n-4) + T(n-2) + O(1)$

B $T(n) = T(n-1) + T(0) + O(n)$

C $T(n) = 2T(n/2) + O(n)$

D $T(n) = 4T(n/2) + O(n)$

Topic : Algorithm 2019 : CS

#Q. Which of the following algorithms can be used to most efficiently find whether a cycle is present in a given graph ?

A Prim's minimum Spanning Tree Algorithm

B Breadth First Search

C Depth First Search

D Kruskal's Minimum spanning tree Algorithm

Topic : Algorithm 2019 : CS

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#Q. Consider an array of positive integers between 123456 to 876543, which sorting algorithm can be used to sort these number in linear time ?

A. Impossible to sort in linear time

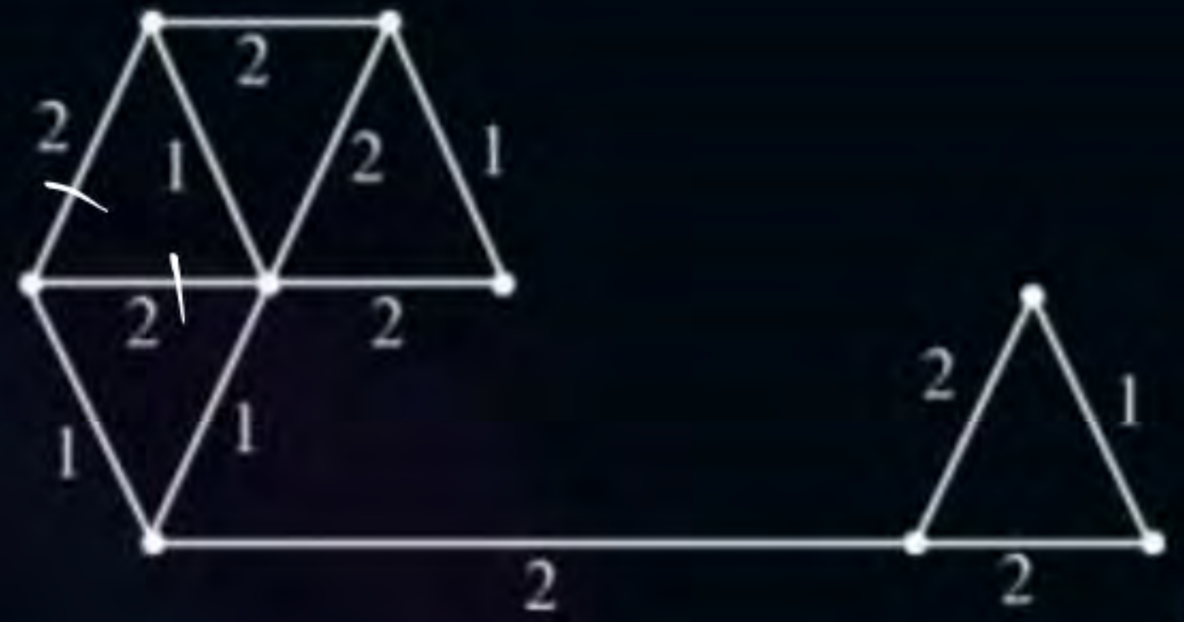
B. Radix sort

C. Insertion Sort

D. Bubble Sort

$n = 9;\ e = 8$

#Q. The number of distinct minimum spanning trees for the weighted graph below is ______.



$({}^{2}C_{1}) \cdot {}^{3}C_{1}$

$= \underline{\underline{6}}$

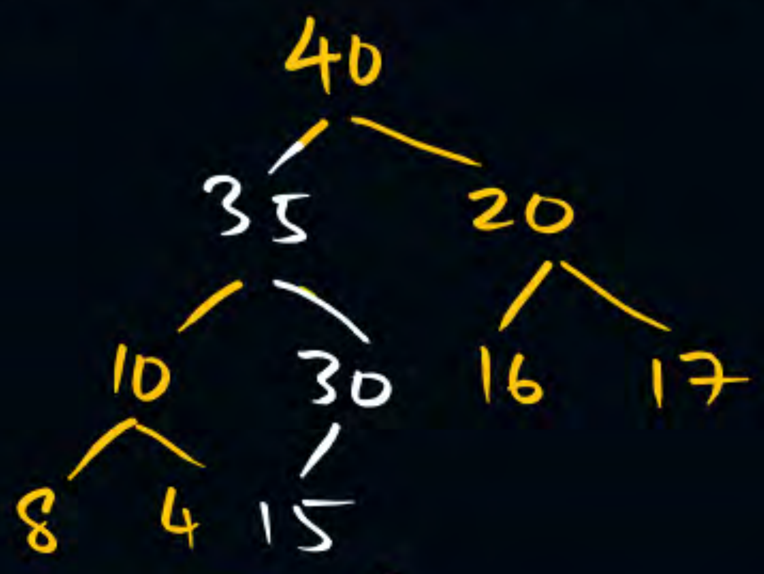
A 4

B 5

C 6

D 7

#Q. Consider a max heap, represented by the array: 40, 30, 20, 10, 15, 16, 17, 8, 4. Now consider that a value 35 is inserted into this heap. After insertion, the new heap is



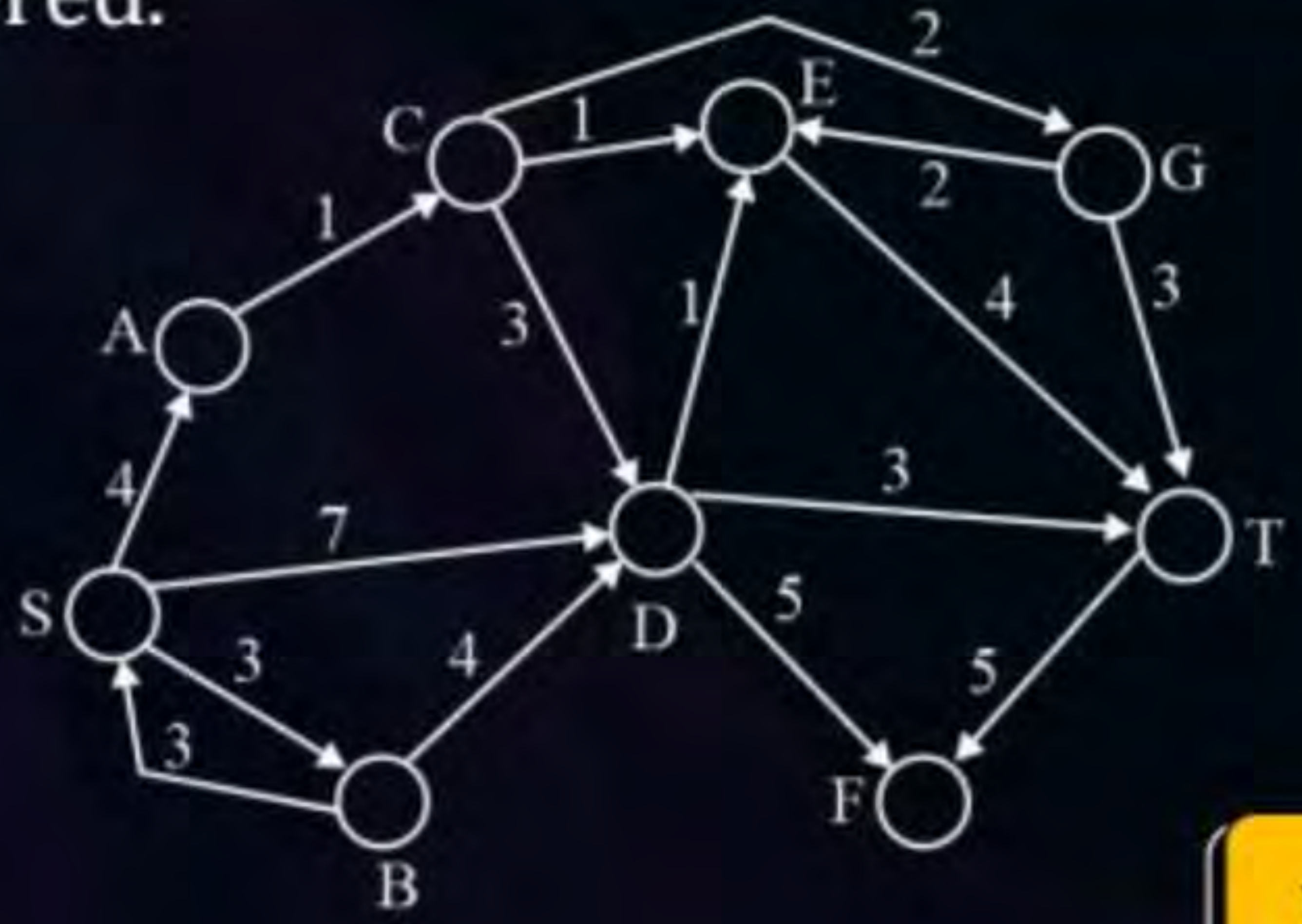
A 40, 30, 20, 10, 15, 16, 17, 8, 4, 35

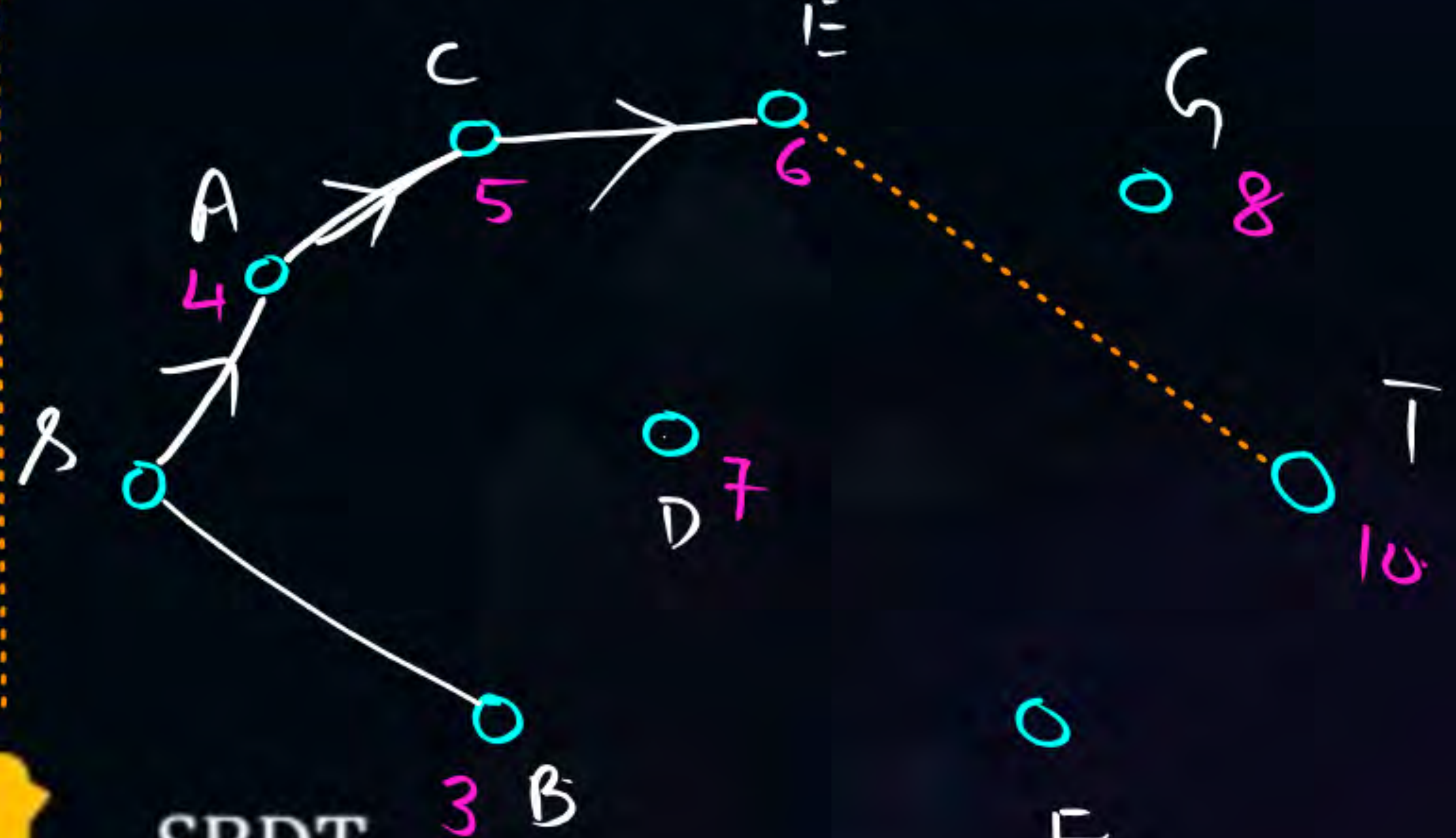
B 40, 35, 20, 10, 30, 16, 17, 8, 4, 15

C 40, 30, 20, 10, 35, 16, 17, 8, 4, 15

D 40, 35, 20, 10, 15, 16, 17, 8, 4, 30

#Q. Consider the directed graph shown in the figure below. There are multiple shortest paths between vertices S and T. Which one will be reported by Dijkstra's shortest path algorithm? Assume that, in any iteration, the shortest path to a vertex v is updated only when a strictly shorter path to v is discovered.





A. SDT

B. SBDT

C. SACDT

D. SACET

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#Q. Which of the following is useful in traversing a given graph by breadth first search?

A Stack

B Set

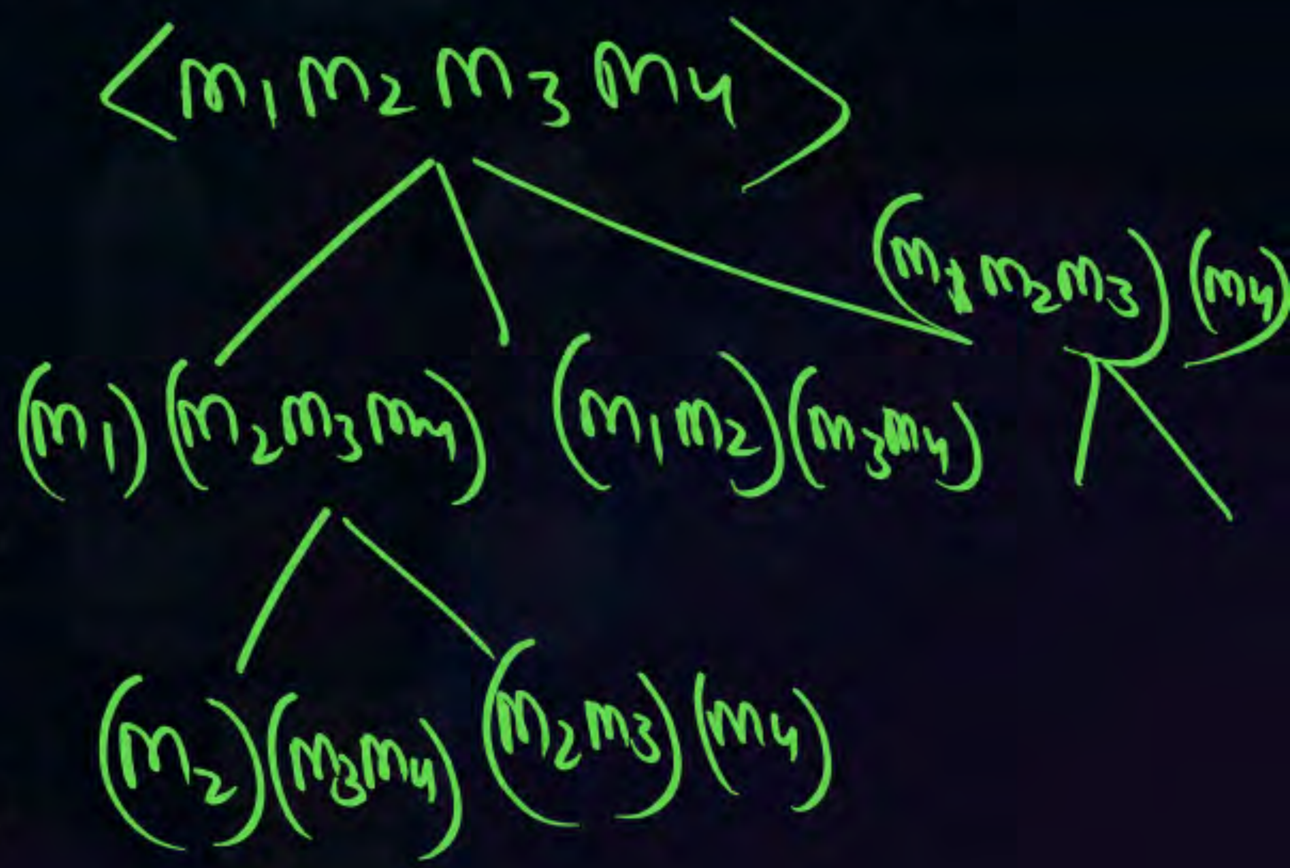
C List

D Queue

Topic : 2017 : CS

#Q. Four matrices M_1, M_2, M_3, and M_4 of dimensions $p \times q$, $q \times r$, $r \times s$ and $s \times t$ respectively can be multiplied in several ways with different number of total scalar multiplications. For example, when multiplied as $((M_1 \times M_2) \times (M_3 \times M_4))$, the total number of multiplications is $pqr + rst + prt$. When multiplied as $(((M_1 \times M_2) \times M_3) \times M_4)$, the total number of scalar multiplications is $pqr + prs + pst$.

If $p = 10$, $q = 100$, $r = 20$, $s = 5$ and $t = 80$, then the number of scalar multiplications needed is



A. 248000

B. 44000

C. 19000

D. 25000

Topic : 2017 : CS

#Q. What are the appropriate data structures for graph traversal using Breadth First Search (BFS) and Depth First Search (DFS) algorithms ?

A. Stack for BFS and Queue for DFS

B. Queue for BFS and Stack for DFS

C. Stack for BFS and Stack for DFS

D. Queue for DFS and Queue for DFS

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#Q. In a given following graph among the following sequences:

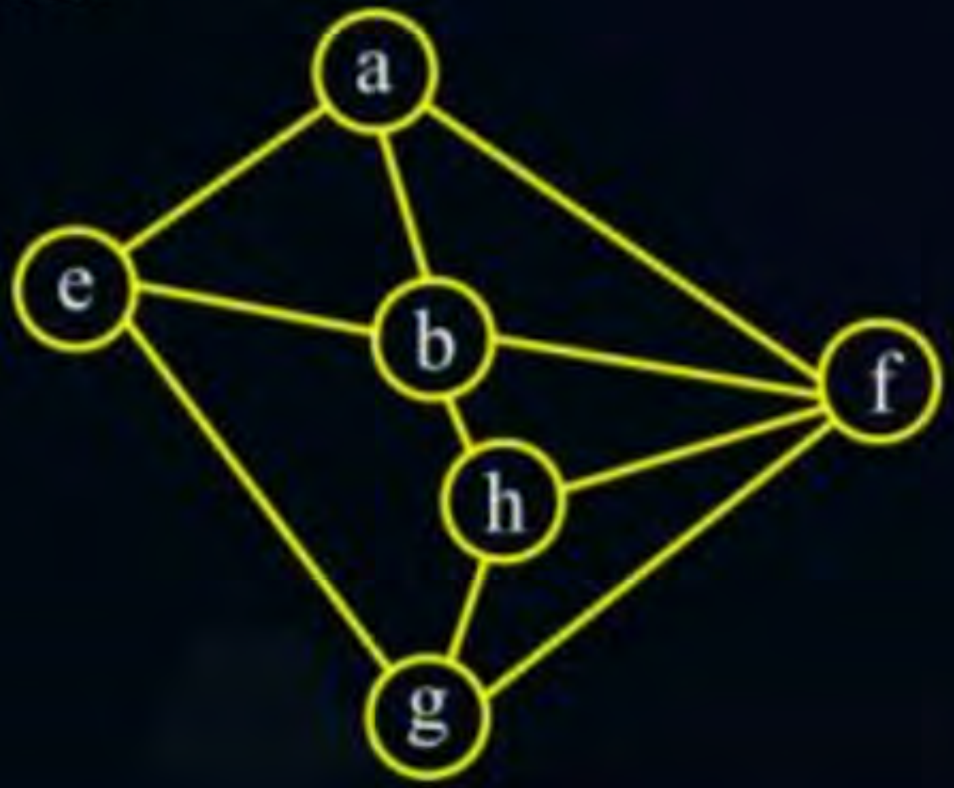
(I) a b e g h f

(II) a b f e h g

(III) a b f h g e

(IV) a f g h b e

Which are depth first traversals of the above graph?



A. I, II and IV only

B. I and IV only

C. II, III and IV only

D. I, III and IV only

#Q. What data structure is used for depth first traversal of a graph?

A Queue

B Stack

C List

D None of above

2 mins Summary

Topic One

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