

CS-6402 DESIGN AND ANALYSIS OF ALGORITHMS

2 marks

UNIT-I

1. Define Algorithm.

An algorithm is a sequence of unambiguous instructions for solving a problem in a finite amount of time.

2. Write a short note on Algorithm Design and Analysis of Process.

- Understand the problem
- Decide on Computational Device Exact Vs Approximate Algorithms
- Algorithm Design Techniques
- Design an algorithms
- Prove Correctness
- Analyze the Algorithm
- Code the Algorithm

3. What are the 2 kinds of Algorithm Efficiency

Time Efficiency-How fast your algorithm runs?

Space Efficiency-How much extra memory your algorithm needs?

4. How can you specify Algorithms?

Algorithms can be specified natural language or pseudo code.

5. What is Pseudo Code?

Pseudo Code is a mixture of Natural Language and Programming Language Constructs such as functions, loops, decision making statements..etc

6. What are the Important Problem Types?

- Sorting
- Searching
- String Processing
- Graph Problem
- Combinatorial Problem
- Geometric Problem
- Numerical Problem

7. How can you Classify Algorithms

Among several ways to classify algorithms, the 2 principal alternatives are

- To group algorithms according to types of problem they solve
- To group algorithms according to underlying design techniques they are based upon

8. What is Sorting Problem?

Sorting algorithm is rearrange the items of given list descending/ascending order. Sorting algorithms classified into

- Stable Sorting Algorithm
- Non-Stable Algorithm

9. What is Searching Problem?

Finding a given value, called search key given set. Searching Algorithms needs more memory space and sorted array.

10. What is Graph Problem?

Graph is a collection of nodes and vertices. $G=(V,E)$. For e.g. Traversal Algorithms, Shortest Path Algorithm, Graph Colouring Problem

11. What is Combinatorial Problem.

This problem that ask to find combinatorial object such as permutations, combinations or a subset. Combinatorial problems are most difficult to solve. For eg Travelling sales man problem

12. Differentiate Time Efficiency and Space Efficiency?

Time Efficiency measured by counting the number of times the algorithms basic operation is executed. Space Efficiency is measured by counting the number of extra memory units consumed by the algorithm.

13. What are the features of efficient algorithm?

- Free of ambiguity
- Efficient in execution time
- Concise and compact
- Completeness
- Definiteness
- Finiteness

14. Define Order of Algorithm

The order of algorithm is a standard notation of an algorithm that has been developed to represent function that bound the computing time for algorithms. The order of an algorithm is a way of defining its efficiency. It is usually referred as O-notation

15. Define Big Omega Notation.

Omega notation provides lower bound for the function t

A function $t(n)$ is said to Omega ($g(n)$), if there exist some positive constant C and some non negative integer N_0 , such that

$$t(n) \geq Cg(n) \text{ for all } n \geq n_0$$

16. What is Big 'Oh' Notation.

The Big 'Oh' notation provides an upper bound for the function t . A function $t(n)$ is said to be $O(g(n))$, if there exist some positive constant C and some non negative number, such that, $t(n) \leq Cg(n)$, for all $n \geq n_0$

17. What are the different types of time complexity?

The time complexity can be classified into 3 types, they are

- Worst case analysis
- Average case analysis
- Best case analysis

18. How the algorithm's time efficiency is measured.

Time efficiency indicates how fast an algorithm runs. Time taken by a program to complete its task depends on the number of steps in an algorithm.

The time taken by an algorithm is the sum of compile time and execution time.

The compile time does not depend on the instance characteristics

UNIT-II

1. What is Empirical Analysis?

It is performed by running a program implementing the algorithm on a sample of inputs and analyzing the data observed. This involves generating pseudocode and random numbers.

2. Define Convex-Hull Problem.

A set of points (finite or infinite) on the plane is called convex if for any two points P and Q in the set, the entire line segment with the end points at P and Q belongs to the set

3. What is Divide and Conquer Algorithm

It is a general algorithm design techniques that solved problem's instance by dividing it into several smaller instance, solving of them recursively, and then combining their solutions to the original instance of the Problem.

4. What are the Features of Algorithm Visualization.

- Consistent
- Interactive
- Very Clear and Concise
- Emphasize the visual component

5. Define O-Notation.

A function $t(n)$ is said to be $O(g(n))$, denoted $t(n) \in O(g(n))$, if $t(n)$ is bounded above by some constant multiple of $g(n)$ for all large n , i.e., if there exist some positive constant c and some nonnegative integer 0 such that

$$t(n) \leq cg(n) \text{ for all } n \geq 0$$

6. What is Algorithm Visualization?

It is defined as the use of images to convey some useful information about algorithms.

7. Define Static Algorithm Visualization?

Static Algorithm Visualization shows an algorithm's progress through a series of still images. On the other hand, Algorithm animation shows a continuous movie-like presentation of an algorithm's operation.

8.. What is Fibonacci Numbers?

The Fibonacci numbers are an important sequence of integers in which every element is equal to the sum of its two immediate predecessors. There are several algorithms for computing the Fibonacci numbers with drastically different efficiency.

9. What are the Classification of Algorithm Visualization?

Static Algorithm Visualization Dynamic Algorithm Visualization

10. What is Brute Force?

Brute Force is a straightforward approach to solving a problem, usually directly based on the problem's statement and definitions of the concepts involved..

11. What are the different criteria used to improve the effectiveness of algorithm?

- Input- Zero or more quantities are externally supplied .
- Output-At least one quantity is produced
- Definiteness-Each instruction is clear and unambiguous
- Finiteness-If we trace out the instructions of algorithm, then for all cases the algorithm terminates after a finite number of steps
- Effectiveness-Every instruction must be very clear

12. What is recursive call?

An algorithm is said to be recursive if the same algorithm is invoked in the body.

There are 2 types of algorithm. They are

- 1) Direct Recursive
- 2) Indirect Recursive

13. What is meant by Direct recursive call?

An algorithm that calls itself is a direct recursive call.

```
Eg.   int fun(int x)
{
    if(x<=0)
    return x;
    return (fun(x-1));
}
```

14. Define indirect recursive call?

Algorithm A is said to be indirect recursive if it calls another algorithm which in turn calls A

```
Eg: int fun(int x)
{
    if(x<=0)
    return x;
    return (f1(x-1));
}
int fun1(int y){
    return fun(y-1)
}
```

15. List the application areas of algorithm visualization?

The 2 application areas of algorithm visualization are Research and Education.

16. Define Extrapolation?

Extrapolation is an approach, which deals with values of n, that are outside of the range of the sample values.

17. Define profiling?

Profiling is an important resource for the empirical analysis of an algorithm's running time.

Measuring different segments of a program can pinpoint a bottleneck in the program's performance that can be missed by an abstract deliberation about the algorithm's basic operations. The process of getting such data is called profiling.

UNIT III

1. What is articulation point?

A vertex of a connected graph G is said to be in articulation point, if its removal with all edges incident to it breaks the graph into disjoint pieces.

2. List the advantages of binary search?

- Less time is consumed
- The processing speed is fast
- The number of iterations is less. It takes $n/2$ iterations.
- Binary search, which is used in Fibonacci Series, involves addition and subtraction rather than division
- It is priori analysis, since it can be analyzed before execution.

3. Explain the principle used quick sort?

It is a partition method using the particular key the given table is partitioned into 2 sub tables so that first, the original key will be its position the sorted sequence and secondly, all keys to the left of this key will be less value and all keys to the right of it will be greater values

4. What is binary search?

The binary search algorithm some of the most efficient searching techniques which requires the list to be sort descending order.

To search for an amount of the list, the binary search algorithms split the list and locate the middle element of the list.

First compare middle key K_1 , with given key K . If $K_1 = K$ then the element is found.

5. What are the objectives of sorting algorithm?

- To rearrange the items of a given list
- To search an element in the list.

6. Why is bubble sort called by the name?

The sorting problem is to compare adjacent elements of the list and exchange them if they are out of order. By doing it repeatedly, we end up bubbling up the largest element to the last position on the list. The next pass bubbles up the second largest element and so on until, after $n-1$ pass the list is sorted.

7. What are the 3 variations in transform and conquer?

The principle variations of transformed and conquer techniques are

- Instance simplification
- Representation change
- Problem reduction

8. Explain principle of Optimality?

The principle of optimality says that an optimal solution to any instance of an optimization problem is composed of optimal solution to its sub instances.

9. What is need for finding minimum spanning tree?

Spanning tree has many applications. Any connected graph with n vertices must have at least $n-1$ edges and connected graphs with $n-1$ edges are trees. If the nodes of G represent cities and edges represent possible communication links connecting 2 cities, then the minimum number of links needed to connect the cities is $n-1$. Therefore, it is necessary for finding minimum spanning tree.

10. What is spanning tree ?

Let $G = \{V, E\}$ be an undirected connected graph. A sub graph $t = \{V, E\}$ of G is a spanning tree of G , if it is tree.

12. What is Dynamic programming?

Dynamic programming is an algorithm design technique for solving problem with overlapping subprograms. The smaller subprograms are solved only once and recording the results in a table from which the solution to the original problem is obtained.

13. What is greedy method?

The greedy method is the most straight forward design, which is applied for change making problem. The greedy technique suggests constructing a solution to an optimization problem through a sequence of steps, each expanding a partially constructed solution obtained so far, until a complete solution to the problem is reached. On each step, the choice made must be feasible, locally optimal

and irrevocable.

14. List the advantage of greedy algorithm

- 1) Greedy algorithm produces a feasible solution
- 2) Greedy method is very simple to solve a problem
- 3) Greedy method provides an optimal solution directly

15. Define the term control abstraction?

Control abstraction is a procedure whose flow of control is learned but whose primary operations are specified by other procedures whose precise meanings are left undefined.

16. List the applications of minimum spanning tree?

Spanning trees are used to obtain an independent set of circuit equations for an electric network. Another application of spanning tree arises from the property that a spanning tree is a minimal subgraph G' of G such that

$$V(G') = V(G) \text{ and } G'$$

17. Define AVL Tree.

An AVL Tree is a binary search tree in which the balance factor of every node, which is defined as the difference between the heights of the node's left and right subtrees, is either 0 or +1 or -1.

18. What do you mean by row major and column major?

In a given matrix, the maximum element in a particular row is called row major. In a given matrix, the maximum element in a particular column is called column major.

19. What is Minimum Cost Spanning Tree?

A minimum cost spanning tree of a weighted connected graph is its spanning tree of the smallest weight, where the weight of the tree is defined as the sum of the weights on all its edges.

UNIT-IV

1. Define mode?

A mode is a value that occurs often in a given list of numbers.

For example, the list is 5, 1, 5, 7, 6, 5, 7, 5 .. the mode is 5.

2. Define rotation?

A rotation in an AVL tree is a local transformation of its subtree rooted at a node, which is performed, when the balance factor of a node is either +2 or -2. If an insertion or deletion of a new node in an AVL Tree creates a tree with a violated balance requirement, then the tree is restructured by performing a special transformation called rotation, that restores the balance required.

3. What are the different types of rotations?

The four types of rotations are

- Right rotation
- Left rotation
- Double right-left rotation
- Double left-right rotation.

4. What are the drawbacks of AVL Tree?

- 1) Frequent rotations are needed to maintain balances from the tree's nodes.
- 2) Deletion is difficult due to the frequency of rotations.
- 3) AVL tree is not considered as a stranded structure for implementing dictionaries.

5. What is a 2-3 tree?

A 2-3 tree is a tree that has 2 kinds of nodes. They are 2 nodes and 3 nodes.

A 2 node contains a single key k and has 2 children

A 3 node contains two ordered keys K_1 and K_2 ($K_1 < K_2$) and has three children

6. Define Heap

Heap is a partially ordered data structure that is especially suitable for implementing priority queues.

A heap is said to be a max heap, then the children of every node have a value less than that node.

A heap is said to be a min heap, then the children of every node have a value greater than the node.

7. What is a priority queue?

Priority queue is a data structure in which the intrinsic ordering of the elements does

determine the results of its basic operations

Ascending and descending priority queue are the 2 types of priority queue.

8. Define warshall's algorithm?

Warshall's algorithm is an application of dynamic programming technique, which is used to find the transitive closure of a directed graph.

9. Define Floyd's algorithm?

Floyd's algorithm is an application, which is used to find all the pairs shortest paths problem.

Floyd's algorithm is applicable to both directed and undirected weighted graph, but they do not contain a cycle of a negative length

10. Define prim's algorithm.

Prim's algorithm is greedy and efficient algorithm, which is used to find the minimum spanning tree of weighted connected graph

11. How efficient is prim's algorithm?

The efficiency of the prim's algorithm depends on data structure chosen for the graph.

12. What is path compression?

The better efficiency can be obtained by combining either variation of quick union with path compression. Path compression makes every node encountered during the execution of a find operation point to the tree's node.

13. Define Dijkstra's Algorithm?

Dijkstra's algorithm solves the single source shortest path problem of finding shortest paths from a given vertex (the source), to all the other vertices of a weighted graph or digraph.

Dijkstra's algorithm provides a correct solution for a graph with non negative weights.

14. Define Huffman trees?

A Huffman tree is binary tree that minimizes the weighted path length from the root to the leaves containing a set of predefined weights.

The most important application of Huffman trees are Huffman code.

15. What do you mean by Huffman code?

A Huffman code is an optimal prefix tree variable length encoding scheme that assigns bit strings to characters based on their frequencies in a given text.

16. What is meant by compression ratio?

Huffman's code achieves the compression ratio, which is a standard measure of compression algorithms effectiveness of

$$\begin{aligned} (3-2.25)/3 \times 100 &= 0.75/3 \times 100 \\ &= 0.25 \times 100 \\ &= 25\%. \end{aligned}$$

17. List the advantage of Huffman's encoding?

Huffman's encoding is one of the most important file compression methods.

1. It is simple
2. It is versatility
3. It provides optimal and minimum length encoding

19. What is dynamic Huffman coding?

In dynamic Huffman coding, the coding tree is updated each time a new character is read from the source text. Dynamic Huffman encodings used to overcome the drawback of simplest version.

20. What do you mean by optimal solution?

Given problem with inputs, we obtain subset that satisfies some constraints. Any subset that satisfies these constraints is called a feasible solution. A feasible solution, which either maximizes or minimizes a given objective function is called optimal solution.

UNIT-V

1. Define backtracking?

Depth first node generation with bounding function is called backtracking. The backtracking algorithm has its virtue the ability to yield the answer with far fewer than m trials.

2. What is Hamiltonian cycle in an undirected graph?

A Hamiltonian cycle is round trip along n edges of G that visits every vertex once and returns to its starting position.

3. What is Feasible solution?

It is obtained from given n inputs Subsets that satisfies some constraints are called feasible solution. It is obtained based on some constraints

4. What is optimal solution?

It is obtained from feasible solution.

Feasible solution that maximizes or minimizes a given objective function. It is obtained based on objective function.

5. List the application of backtracking technique?

8-Queens problem

6. Given an application for knapsack problem?

The knapsack problem is problem combinatorial optimization. It derives its name from the maximum problem of choosing possible essential that can fit too bag to be carried on trip. A similar problem very often appears business, combinatory, complexity theory, cryptography and applied mathematics.

7. Define subset sum problem?

Subset sum problem is problem, which is used to find a subset of a given set $S = \{S_1, S_2, S_3, \dots, S_n\}$ of positive integers whose sum is equal to given positive integer d .

8. What is heuristic?

A heuristic is common sense rule drawn from experience rather than from mathematically proved assertion.

For example, going to the nearest un visited city in the travelling salesman problem is good example for heuristic.

9. State the concept of branch and bound method?

The branch and bound method refers to all state space search methods in which all children of the E-Node are generated before any other live node can become the E-node.

10. Give the upper bound and lower bound of matrix multiplication algorithm?

Upper bound: The given algorithm does $n \times n \times n$ multiplication hence at most $n \times n \times n$ multiplication are necessary.

Lower bound: It has been proved in the literature that at least $n \times n$ multiplication are necessary.

11. What is state space tree?

Backtracking and branch bound are based on the construction of a state space tree, whose nodes reflect specific choices made for a solution's component. Its root represents an initial state before the search for a solution begins.

The nodes of the first level the tree represent the made for the first component of solution, the nodes of the second level represent the Choices for the second components & so on

12. What is promising and non promising node?

A node state space tree is said to be promising, if it corresponds to a partially constructed solution that may still lead to complete solution. Otherwise, node is called non- promising.

13. What are the additional items are required for branch and bound compare to backtracking technique?

Compared to backtracking, branch and bound requires 2 additional items.

1) A way to proved, for every node of node of state space tree, a bound on the best value of the objective function on any solution that can be obtain d by adding further components to the partial solution represented by the node.

2) The value of the best solution seen so far.

14. Differentiate backtracking and branch bound techniques.

- Backtracking is applicable only to non optimization problems.
- Backtracking generates state space tree depth first manner.
- Branch and bound is applicable only to optimization problem.

- Branch and bound generated a node of state space tree using best first rule.

15. What is called all pair shortest path problem?

Given a weighted connected graph, the all pairs shortest paths problem is to find the distances from each vertex to all other vertices.

16. When do you say a tree as minimum spanning tree?

A spanning tree is said to be minimum spanning tree when the weight of the spanning tree is smallest, where the weight of a tree is defined as the sum of the weight of all its edges.

17. How will you construct an optimal binary search tree?

A binary search tree is one of the most important data structures in computer sciences. its principal applications are to implement a dictionary, a set of elements with the operations of searching, insertion and deletion. If probabilities of searching for elements of a set are known as optimal binary search tree, for which the average number of comparisons in a search is the smallest possible.

18. What is the runtime of shortest path algorithm?

The runtime of shortest path algorithm is $\theta((n+|E|) \log n)$

19. What is mathematical modelling?

Mathematical modelling is method of expressing problem in terms of purely Mathematical objects such as variables, functions and equations.

20. What is pre structure?

Pre structuring is type of technique that exploits space for time tradeoffs simply uses extra space of facilities faster and or more flexible access to data.

21. Define Heap sort?

Heap sort is sorting algorithm. Heap sort is 2 stage algorithm. The two stages are

Stage 1- Heap Construction- Construct heap for a given array of elements

Stage 2- Maximum Deletion- Apply the root deletion operation $n-1$ times to the remaining heap.