Farhan-46

1.A thief made his way to a shop.

As usual he has his lucky knapsack with him. The knapsack can contain k objects. There are n kinds of products in the shop and an infinite number of products of each kind. The cost of one product of kind i is ai.

The thief is greedy, so he will take exactly k products (it's possible for some kinds to take several products of that kind).

Find all the possible total costs of products the thief can nick into his knapsack.

2.Mike takes part in programming contests. His favourite topic is dynamic programming(DP). As he said, that he likes problems on DP, because "you spend a lot of time on thinking and a little time on coding".

In this problem you are to solve a version of the knapsack problem, one of the most famous examples of DP problem.

You are given N items, each has two parameters: a weight and a cost. Let's define M as the sum of the weights of all the items.

Your task is to determine the most expensive cost of a knapsack, which capacity equals to 1, 2, ..., M. A cost of a knapsack equals to the sum of the costs of all the elements of the knapsack. Also, when you have a knapsack with a capacity is equal to C, then you can fill it with items, whose sum of weights is not greater than C.

3.You are given n projects, each with a cost and profit. You have a total budget B. Select projects to maximize total profit without exceeding budget.

4.There are n courses. Each course requires certain time and gives some credits. Choose courses to maximize credits within a total time limit.

5.How many ways can you use the coins {1, 3, 4} (used any number of times) to make sum = 6

6.Choose a subset of items with weight {1, 3, 4} and value {10, 40, 50} such that total weight ≤ 6. You can’t repeat ite.

Tanvir-85

1. Advanced Variable-Length Encoding

You are given the message:

"NSNIDTHIADTI"

a) Construct an optimal variable-length binary encoding for the message based on character frequency.

i. What is the cost (in bits) of transmitting the message using this encoding?

ii. Compare this with fixed-length encoding.

b) Decode the following binary strings assuming an optimal prefix code generated from any meaningful distribution:

i. 110111101111010

ii. 1110001010000010010

(Provide all possible valid decoded strings or indicate ambiguity if decoding is not unique.)

2. Encoding Bit Estimation

Given a system with 35 unique printable characters,

a) What is the minimum and maximum number of bits needed per character using fixed-size encoding?

b) What would change if the characters are not equally probable?

3. Sorting Logic Analysis

Explain how the internal logic of Selection Sort and Insertion Sort affects their performance on:

Nearly sorted arrays

Reverse sorted arrays

Provide a dry-run example to justify your answer.

4. Time Complexity with Non-Trivial Loop

Analyze the time complexity of the following function using recurrence relation and identify whether it falls under any known complexity class:

void Test(int n)

{

if(n >= 0)

{

Test(n - 1);

for(int i = 1; i < n; i \*= 2)

{

state;

}

}

}

Also determine:

Base case

Recurrence relation

Final complexity with Big-O

5. Coin Change with Constraint

You are given unlimited coins of denominations {1, 2, 3}.

a) Find the minimum number of coins required to make 5 taka using bottom-up dynamic programming.

b) Now, if only two coins of 3 taka are allowed, can you still make 5? Justify with updated DP table or logic.

6. Merge Sort Depth Analysis

If a recursive merge sort algorithm takes exactly 5 recursive levels,

a) What is the range of total number of elements n such that log₂(n) = 5?

b) What would be the size of subarrays at the lowest level?

7. Custom Sorting with Step Limit

Take the last 8 digits of your mobile number.

a) Sort them using any algorithm such that the number of element comparisons is exactly 28.

b) Prove that the algorithm and input both satisfy this constraint.

8. Bit-Cost of Numeric Message

A phone number 01777777779 is to be transmitted over a binary channel.

a) Calculate the total number of bits if:

i) BCD (4 bits per digit) is used

ii) Huffman encoding is applied with digit frequency of the number

b) Which method is more efficient in this case and why?

9. Stack Frame Insight

Consider the following recursive call:

int fun(int n) {

if(n <= 0) return 1;

return n \* fun(n - 1);

}

int main() {

fun(5);

return 0;

}

a) How many stack frames are created during the execution?

b) What happens to them after each return?

10. Optimal Sorting Selection

Given an already sorted array, select the most efficient sorting algorithm from:

Merge Sort

Selection Sort

Insertion Sort

Bubble Sort

a) Justify your choice based on best-case complexity

b) Can your choice change if the array has 1 misplaced element?

🛒 11. Delivery Drone Optimization

A delivery drone can carry up to 10kg. You have the following items:

Item Weight (kg) Value (Taka)

A 6 60

B 3 50

C 4 70

Question:

What is the maximum value the drone can carry without exceeding the weight limit?

Also, which items should be selected?

📱12. Sending a Phone Number Over Network

You need to send the number 01777777779 using a digital communication system.

Question:

Estimate the minimum number of bits needed to send this number using an efficient encoding method.

Explain your approach.

📚 13. Merging Sorted Book Piles

You have 4 sorted book piles containing: [20, 30, 10, 5] books.

Question:

What is the minimum total cost (in terms of steps or effort) to merge all the piles into one?

Show your merging sequence and justify your answer.

🍔 14. Food Combo Optimization

A restaurant offers the following combos:

Combo Price Calories

A 30 500

B 50 800

C 20 300

Your budget is 100 Taka.

Question:

What is the maximum calorie value you can get within the budget?

Which combos should you choose?

🧬 15. DNA Sequence Matching

Two DNA strands are given:

A = "AGGTAB"

B = "GXTXAYB"

Question:

Find the maximum matching subsequence that appears in both strands while maintaining order.

✍ 16. Correcting a Misspelled Word

Suppose someone typed algorthm instead of algorithm.

Question:

What is the minimum number of steps needed to convert the wrong word to the correct one using insertions, deletions, or replacements?

Show the transformation process.

🚚 17. Sorting for Logistics

You are given the following package weights:

[10, 20, 50, 40, 30, 60, 70]

Question:

Sort the packages using a suitable approach that takes minimum operations, given that the list is mostly sorted.

Justify your steps.

📦 18. Warehouse Space Problem

You have several products with different volumes and profits. The warehouse has limited space.

Question:

How would you choose which products to store in order to maximize profit without exceeding the volume limit?

🧮 19. Efficient Number Calculation

Suppose you are asked to calculate a large numbered series like Fibonacci(1000).

Question:

What approach would you take to make the calculation efficient and avoid unnecessary repetition?

📶 20. Compressing Repetitive Log Messages

You have a log message:

ERRORERRORERRORINFOERROR

Question:

Suggest a way to compress the message so that it takes the least number of bits for transmission.

You are building an app that helps people plan monthly expenses under a fixed budget.

Categories include food, rent, education, entertainment, and transport.

Question:

How would you select the best combination of expenses to maximize satisfaction without exceeding the budget?

Adhara-70

1.Item with Zero Weight and High Profit- fractional knapsack.

2. What would be the value of the knapsack with capacity 5 and items [(weight=2, value=12), (weight=1, value=10), (weight=3, value=20)]?

a) 22

b) 30

c) 32

d) 42

3.In which case can the 0/1 Knapsack problem be solved using a greedy method with correct results?

a) Always

b) When all values are equal

c) When items are divisible

d) When value/weight ratio is equal for all items

4.In the classical LCS problem, the time complexity is O(m × n) for strings of length m and n. Are there known approaches or optimizations that can improve this complexity in specific cases (e.g., when alphabets are small, or strings have particular structures), and how do these optimizations affect the correctness and general applicability of the LCS algorithm?”

5.You are given an unlimited supply of coins of denominations: [1, 3, 5, 7].

You need to find:

The number of distinct ways to make the amount N = 15.

The minimum number of coins needed to make the amount N = 15.

Additionally, if you limit the usage of the coin 5 to at most 2 coins, how many distinct ways are there to make amount 15 now?

6.What is the base case for the number of ways to make change using DP?

7.You are given coin denominations: [1, 2, 5]

You are asked to make amount = 10 taka

what if you are not allowed to use more than two 2-taka coins?

Now, how many ways are there to make 10 taka?

Is the minimum number of coins still the same?

8.Which of the following is true about the Edit Distance problem?

a) It is a variation of Longest Common Subsequence

b) It is solved using Greedy Algorithm

c) It always returns 0 for strings of different lengths

d) it can only be solved by backtracking ... ekhane kivabe ans 1 hoy..amra to jani j edit distance jeta ber hoy oita hcche no of operations.. tahole kivabne eita lcs er variation.. lcs e to amra char likhi..jemon Arjun ar Raju er moddhe ans hocche aju.

Tajul-63

1.In a DP table dp[n+1][W+1] for 0/1 Knapsack, what does each entry dp[i][w] represent?

A) Minimum weight to get value i with capacity w  
 B) Maximum profit using first i items and capacity w  
 C) Minimum items needed to fill capacity w  
 D) Total number of ways to reach capacity w

2.Given 3 items with (profit, weight): (60,10), (100,20), (120,30). Knapsack capacity is 50. What is the maximum profit using 0/1 Knapsack?

A) 220  
 B) 180  
 C) 240  
 D) 280

3.Why is sorting items by value-to-weight ratio not a good strategy for 0/1 Knapsack?

A) Because it is computationally expensive  
 B) Because it may exceed memory limits  
 C) Because it only works for fractional knapsack  
 D) Because it results in negative values