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Tutorial - 7

Ans 1 = Greedy is an algorithmic paradigm that builds up a solution piece by piece, always choosing the next piece that offers the most obvious and immediate benefit. This means that it makes a locally optimal choice in the hope that this choice will lead to a globally optimal solution.

A problem must comprise these two components for a greedy algorithm to work:

1. It has optimal substructures. The optimal solution for the problem contains optimal solutions to the sub-problems.

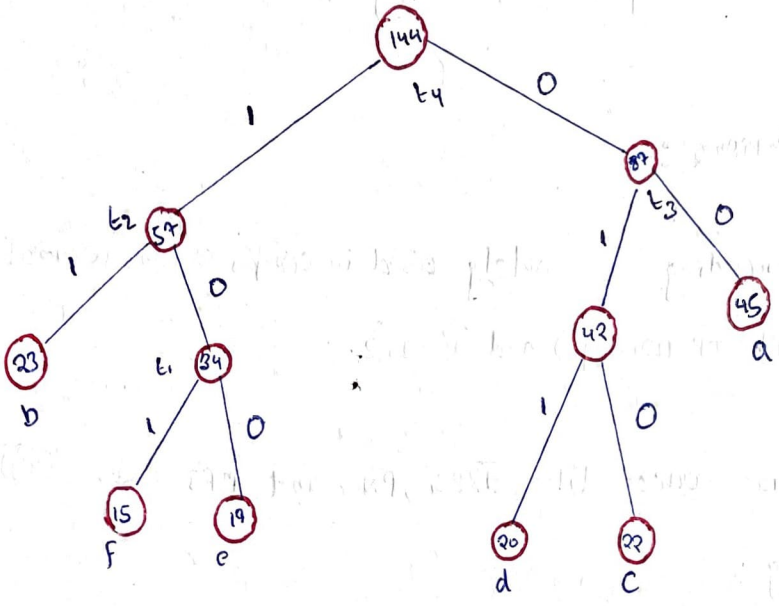
2. It has a greedy property (hard to prove its correctness). If you make a choice that seems the best at that moment and solve the remaining sub-problems later, you still reach an optimal solution. You will never have to reconsider your earlier choices.

Ans 2 =

	Time Complexity	Space Complexity
Activity Selection	$O(n \log n)$ → Not Sorted $O(n)$ → Sorted	$O(1)$
Job Sequencing	$O(n^2)$ $O(n \log n)$ → Priority Queue	$O(n)$

Fractional Knapsack	O(nlogn)	O(1)
Huffman Encoding	O(nlog n)	O(n)

Ans 3:



Letters	Huffman Code	Frequency	No. of bits
a	0 0	45	90
b	1 1	23	46
c	0 1 0	22	66
d	0 1 1	20	60
e	1 0 0	19	57
f	1 0 1	15	45
		144	364

$$\text{Avg. length} = \frac{364}{144} = 2.5277$$

Ans 4 = Priority queue is used for building the Huffman tree such that nodes with lowest frequency have the highest priority. A Min Heap Data Structure can be used to implement the functionality of a priority queue.

Applications :-

- Huffman Encoding is widely used in compression formats like GZIP, PKZIP (Winzip) and BZIP2.
- Multimedia codecs like JPEG, PNG and MP3 uses Huffman Encoding.
- Huffman Encoding still dominates the compression Industry.

Ans 5 =

Value	6	10	18	15	3	5	7
weight	1	2	4	5	1	3	7
V/W	6	5	4.5	3	3	1.66	1

Max Weight = 15

Weight = 6 + 10 + 18 + 15 + 3 + 1.66 * 2

= 52 + 3.33

= 55.33 units

Ans 6:

In Fractional Knapsack Problem the basic idea of the greedy approach is to calculate the ratio value/weight for each item and sort the item on basis of this ratio. Then take the item with the highest ratio and add them until we can't add the next item as a whole and at the end add the next item as much as we can.

In Huffman Encoding, the algorithm builds the tree T analogous to the optimal code in a bottom-up manner. It starts with a set of |C| leaves (C is the number of characters) and performs |C| - 1 'merging' operations to create the final tree. In Huffman's greedy algorithm uses a table of the frequencies of occurrences of each character to build up an optimal way of representing each character as a binary string.

Ans 7:

Start Time	1	2	0	6	9	10
End Time	3	5	7	8	11	12

Start Time — End Time

(1) – (3)

(6) – (8)

(9) – (11)

} Max. Activities = 3

Ans 8=

	a	b	c	d	e
PROFIT	20	15	10	5	1
DEADLINE	2	2	1	3	3

Max Deadline = 3

⇓

Therefore Max Array Size = 3

0	1	2	3
	C	a	d
	10	20	5

10 + 20 + 5 = 35

Ans 9= Sometimes greedy algorithms fail to find the globally optimal solution because they do not consider all the data. The choice made by a greedy algorithm may depend on choices it has made so far, but it is not aware of future choices it could make.

Ex :-

Let us consider that the capacity of the knapsack is W = 25 and the items are as shown in the following table :-

Profit	24	18	18	10
weight	24	10	10	7

Without considering the profit per unit weight (p_i/w_i), if we apply Greedy approach to solve this problem First item A will be selected as it will contribute

maximum profit among all the elements.

After selecting item A, no more item will be selected. Hence, for this given set of items total profit is 24. Whereas, the optimal solution can be achieved by selecting items, B and C, where the total profit is $18+18=36$.

Ans 10= We can optimize the approach of solving Job Sequencing problem by using Priority Queue (Max Heap).

Algorithm :-

- Sort the jobs based on their deadlines.
- Iterate from the end and calculate the available slots between every two consecutive deadlines. Include the profit, deadline, and job ID of i^{th} job in the max heap.
- While the slots are available and there are jobs left in the max heap, include the job ID with maximum profit and deadline in the result.
- Sort the result array based on their deadlines.