1. Write and explain with examples the Knapsack problem.
Answer :

Here the knapsack is like a container or a bag. Suppose we have given some items which have some weights or profits. We have to put some items in the knapsack in such a way that total value produces a maximum profit.
For example, the weight of the container is 20 kg. We have to select the items in such a way that the sum of the weight of items should be either smaller than or equal to the weight of the container, and the profit should be maximum. It is a combinational optimization problem.
There are two types of knapsack problems:

- 0/1 knapsack problem
- Fractional knapsack problem

Let us consider that the capacity of a knapsack is w = 60 and the list of the provided items are shown in the following table :

Item	A	B	C	D
Profit	280	100	120	120
Weight	40	10	20	24
Ratio (piwi)	7	10	6	5

The provided items are sorted into decreasing order of the ratio or piwi, where **piwi=Profit/Weight**

After sorting the table as per piwi:

Item	B	A	C	D
Profit	100	280	120	120
Weight	10	40	20	24
Ratio (piwi)	10	7	6	5

At first B is chosen because the weight of B is less than the capacity of the knapsack.
Remaining capacity = 60-10=50
Next A is chosen as the remaining capacity is greater than the weight of A.
Remaining capacity = 50-40=10
Now the next item is C. But it cannot be chosen according to the 0/1 knapsack problem, as the weight of C is greater than the remaining capacity.
If we introduce fractional knapsack here, then item C is taken after making the partition. So we take 10kg from C.
Now the knapsack is full.

Profit for B=100
Profit for A=280
Profit for C=10*6=60
Therefore, **net profit = 100+280+60 = 440**

2. Find the step by step solution of 5 queens. (any three solutions).
Answer:

Step 1: At first we choose the 1st cell according to the backtracking algorithm and put 1 there. Then put X along the diagonal and vertical cells. Move for the next row.

1				
X	X			
X		X		
X			X	
X				X

Step 2: In this row the first empty cell is 3, put 1 there. Next fill vertical and diagonal cells with X. Move to the next row.

1				
X	X	1		
X	X	X	X	
X		X	X	X
X		X		X

Step 3: In this row the first empty cell is 5, put 1 there. Vertical and diagonal cells are already filled with X. Move to the next row.

1				

X	X	1		
X	X	X	X	1
X		X	X	X
X		X		X

Step 4: In this row the first empty cell is 2, put 1 there. Fill vertical and diagonal cells with X. Move to the next row.

1				
X	X	1		
X	X	X	X	1
X	1	X	X	X
X	X	X		X

Step 5: Fill the last empty cell and there comes a successful solution.

1				
X	X	1		
X	X	X	X	1
X	1	X	X	X
X	X	X	1	X

SOLUTION 1: [x1=1, x2=3, x3=5, x4=2, x5=4]

Another Solution

Step 1: At first we choose the 1st cell according to the backtracking algorithm and put 1 there. Then put X along the diagonal and vertical cells. Move for the next row.

1				
X	X			
X		X		
X			X	
X				X

Step 2: In this row the second empty cell is 4,(1st empty cell was used for solution 1) put 1 there. Next fill vertical and diagonal cells with X. Move to the next row.

1				
X	X		1	
X		X	X	
X	X		X	
X			X	X

Step 3: In this row the first empty cell is 2, put 1 there.Fill vertical and diagonal cells with X. Move to the next row.

1				

X	X		1	
X	1	X	X	
X	X	X	X	
X	X		X	X

Step 4: In this row the first empty cell is 5, put 1 there.Vertical and diagonal cells are already filled with X. Move to the next row.

1				
X	X		1	
X	1	X	X	
X	X	X	X	1
X	X		X	X

Step 5: Fill the last empty cell and there comes a successful solution.

1				
X	X		1	
X	1	X	X	
X	X	X	X	1

X	X	1	X	X

Solution 2: [x1=1, x2=4, x3=2, x4=5, x5=3]

Another Solution

Step 1: At first we choose the second cell (1st empty cell was used for the previous solution) according to the backtracking algorithm and put 1 there. Then put X along the diagonal and vertical cells. Move for the next row.

	1			
X	X	X		
	X		X	
	X			X
	X			

Step 2: In this row the first empty cell is 4, put 1 there. Next fill vertical and diagonal cells with X. Move to the next row.

	1			
X	X	X	1	
	X	X	X	X
	X		X	X
X	X		X	

Step 3: In this row the first empty cell is 1, put 1 there. Next fill vertical and diagonal cells with X. Move to the next row.

	1			
X	X	X	1	
1	X	X	X	X
X	X		X	X
X	X	X	X	

Step 4: In this row the first empty cell is 3, put 1 there.Vertical and diagonal cells are already filled with X. Move to the next row.

	1			
X	X	X	1	
1	X	X	X	X
X	X	1	X	X
X	X	X	X	

Step 5: Fill the last empty cell and there comes a successful solution.

	1			
X	X	X	1	
1	X	X	X	X

X	X	1	X	X
X	X	X	X	1

Solution 3: [x1=2, x2=4, x3=1, x4=3, x5=5]
For these 3 solutions no backtracking was required.

3. Write and explain Prim's algorithm with examples.
Answer:

Prim's Algorithm-

- Prim's Algorithm is a famous greedy algorithm.
- It is used for finding the Minimum Spanning Tree (MST) of a given graph.
- To apply Prim's algorithm, the given graph must be weighted, connected and undirected.

Prim's Algorithm Implementation-

The implementation of Prim's Algorithm is explained in the following steps-

Step-01: Randomly choose any vertex.

Step-02: The vertex connecting to the edge having least weight is usually selected.

Step-03: Find all the edges that connect the tree to new vertices.

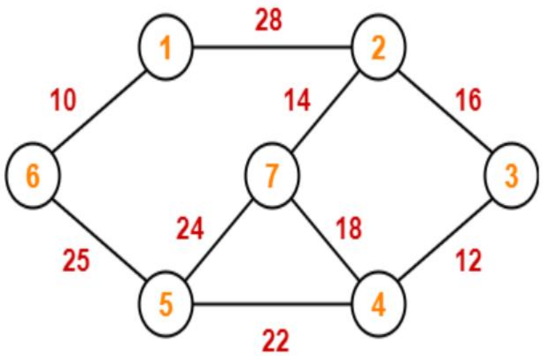
Step-04: Find the least weight edge among those edges and include it in the existing tree.

Step-05: If including that edge creates a cycle, then reject that edge and look for the next least
weight edge.

Step-06: Keep repeating step-02 until all the vertices are included and Minimum Spanning Tree (MST) is obtained.

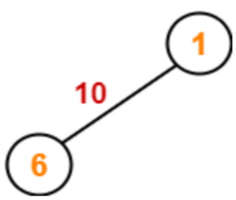
Example:

Construct the minimum spanning tree (MST) for the given graph using Prim's Algorithm-

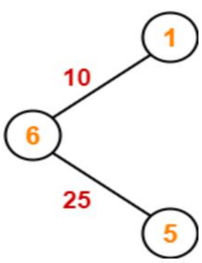


Solution:
The above discussed steps are followed to find the minimum cost spanning tree using Prim's Algorithm-

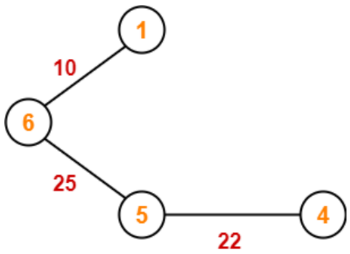
Step-01:



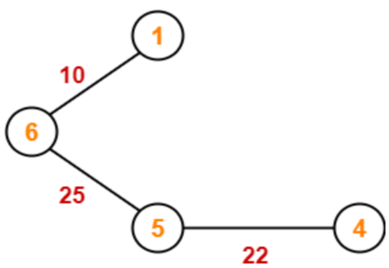
Step-02:



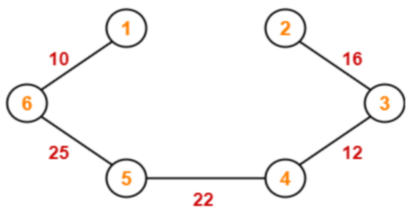
Step-03:



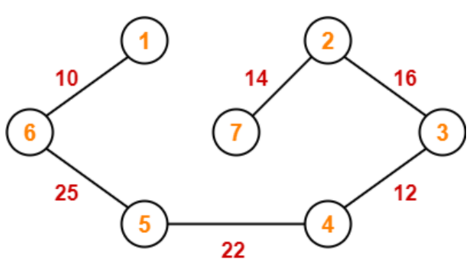
Step-04:



Step-05:



Step-06:



Since all the vertices have been included in the MST, so, we stop.
Now, Cost of Minimum Spanning Tree
= Sum of all edge weights
= 10 + 25 + 22 + 12 + 16 + 14
= 99 units