

## **Assignment No: 3**

**Title of the Assignment:** Write a program to solve a fractional Knapsack problem using a greedy method.

**Objective of the Assignment:** Students should be able to understand and solve fractional Knapsack problems using a greedy method.

**Prerequisite:**

1. Basic of Python or Java Programming
  2. Concept of Greedy method
  3. fractional Knapsack problem
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**Contents for Theory:**

1. Greedy Method
  2. Fractional Knapsack problem
  3. Example solved using fractional Knapsack problem
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## What is a Greedy Method?

- A greedy algorithm is an approach for solving a problem by selecting the best option available at the moment. It doesn't worry whether the current best result will bring the overall optimal result.
- The algorithm never reverses the earlier decision even if the choice is wrong. It works in a top-down approach.
- This algorithm may not produce the best result for all the problems. It's because it always goes for the local best choice to produce the global best result.

## Advantages of Greedy Approach

- The algorithm is **easier to describe**.
- This algorithm can **perform better** than other algorithms (but, not in all cases).

## Drawback of Greedy Approach

- As mentioned earlier, the greedy algorithm doesn't always produce the optimal solution. This is the major disadvantage of the algorithm
- For example, suppose we want to find the longest path in the graph below from root to leaf.

## Greedy Algorithm

1. To begin with, the solution set (containing answers) is empty.
2. At each step, an item is added to the solution set until a solution is reached.
3. If the solution set is feasible, the current item is kept.
4. Else, the item is rejected and never considered again.

## Knapsack Problem

You are given the following-

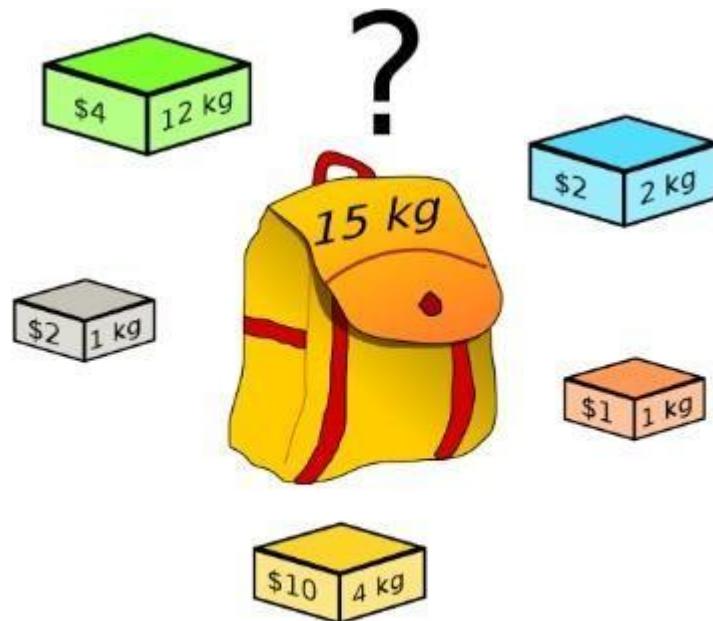
- A knapsack (kind of shoulder bag) with limited weight capacity.

- Few items each having some weight and value.

The problem states-

Which items should be placed into the knapsack such that-

- The value or profit obtained by putting the items into the knapsack is maximum.
- And the weight limit of the knapsack does not exceed.



### **Knapsack Problem**

## **Knapsack Problem Variants**

Knapsack problem has the following two variants-

1. Fractional Knapsack Problem
2. 0/1 Knapsack Problem

## **Fractional Knapsack Problem-**

In Fractional Knapsack Problem,

- As the name suggests, items are divisible here.
- We can even put the fraction of any item into the knapsack if taking the complete item is not

possible.

- It is solved using the Greedy Method.

## **Fractional Knapsack Problem Using Greedy Method-**

Fractional knapsack problem is solved using greedy method in the following steps-

### **Step-01:**

For each item, compute its value / weight ratio.

### **Step-02:**

Arrange all the items in decreasing order of their value / weight ratio.

### **Step-03:**

Start putting the items into the knapsack beginning from the item with the highest ratio.

Put as many items as you can into the knapsack.

## **Problem-**

For the given set of items and knapsack capacity = 60 kg, find the optimal solution for the fractional knapsack problem making use of greedy approach.

Item	Weight	Value
1	5	30
2	10	40
3	15	45
4	22	77
5	25	90

$$n = 5$$

$$w = 60 \text{ kg}$$

$$(w_1, w_2, w_3, w_4, w_5) = (5, 10, 15, 22, 25)$$

$$(b_1, b_2, b_3, b_4, b_5) = (30, 40, 45, 77, 90)$$

## **Solution-**

### **Step-01:**

Compute the value / weight ratio for each item-

Items	Weight	Value	Ratio
1	5	30	6
2	10	40	4
3	15	45	3
4	22	77	3.5
5	25	90	3.6

### **Step-02:**

Sort all the items in decreasing order of their value / weight ratio-

**I1 I2 I5 I4 I3**

(6) (4) (3.6) (3.5) (3)

### **Step-03:**

Start filling the knapsack by putting the items into it one by one.

Knapsack Weight	Items in Knapsack	Cost
60	$\emptyset$	0
55	I1	30
45	I1, I2	70
20	I1, I2, I5	160

Now,

- Knapsack weight left to be filled is 20 kg but item-4 has a weight of 22 kg.
- Since in fractional knapsack problem, even the fraction of any item can be taken.
- So, knapsack will contain the following items-

$< I1, I2, I5, (20/22) I4 >$

#### **Total cost of the knapsack**

$$= 160 + (20/22) \times 77$$

$$= 160 + 70$$

$$= 230 \text{ units}$$

#### **Time Complexity-**

- The main time taking step is the sorting of all items in decreasing order of their value / weight ratio.
- If the items are already arranged in the required order, then while loop takes  $O(n)$  time.
- The average time complexity of Quick Sort is  $O(n\log n)$ .
- Therefore, total time taken including the sort is  $O(n\log n)$ .

**Conclusion**-In this way we have explored Concept of Fractional Knapsack using greedy method

