

Knapsack Problem – Brute Force Approach

Session No.: 12

Course Name: Design and analysis of algorithm

Course Code: R1UC407B

Instructor Name: Anurag Maurya

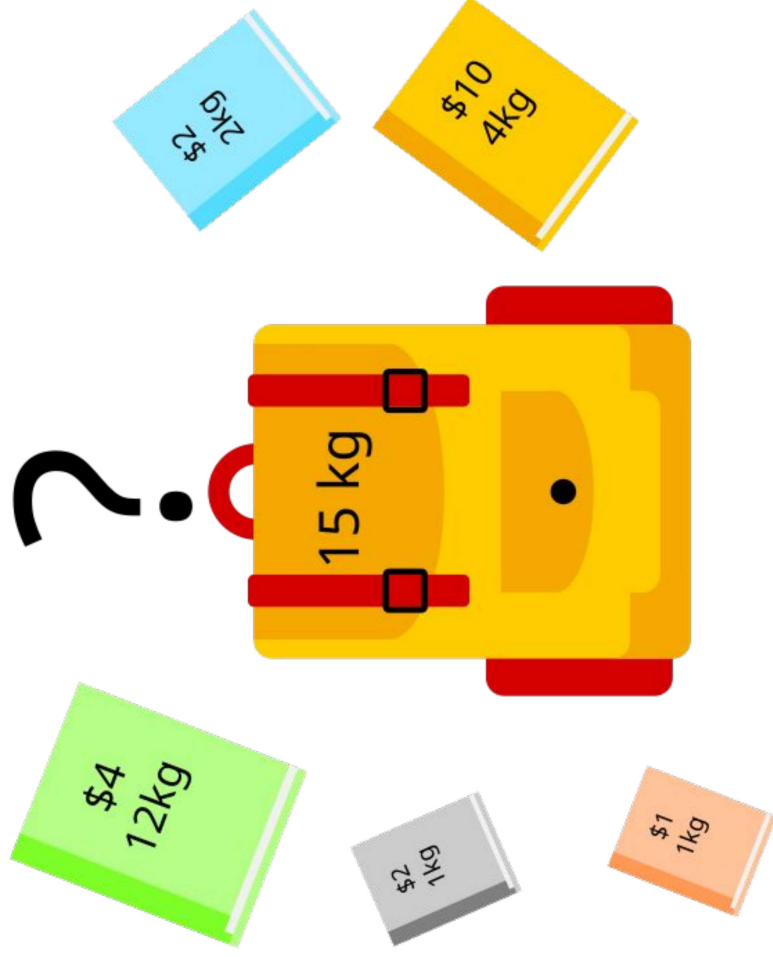
Duration: 50 Min.

Date of Conduction of Class:

Recap

- String Matching
- String Matching: Naïve algorithm
- String Matching: KMP algorithm

Which books should be chosen to maximize the amount of money while still keeping the overall weight under or equal to 15 kg?



Learning Outcome

Explain and solve the Knapsack Problem using brute force method



Analyze its time complexity

Session Outline

1 Problem Statement

2 Learning Activity 1

3 Discussion on Learning Activity 1

4 Learning Activity 2

5 Discussion on Learning Activity 2

6 Conclusion/Exercise

0/1 Knapsack Problem

Problem Definition:

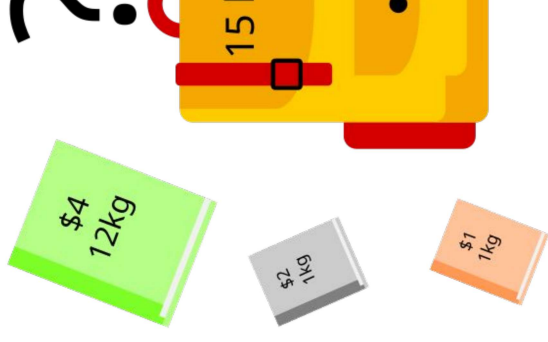
You are given a set of items, each with a weight and a value, and a knapsack with a maximum weight capacity.

Goal:

The objective is to find the subset of items that can be placed in the knapsack without exceeding its capacity, while maximizing the total value of the items chosen.

0/1 Property:

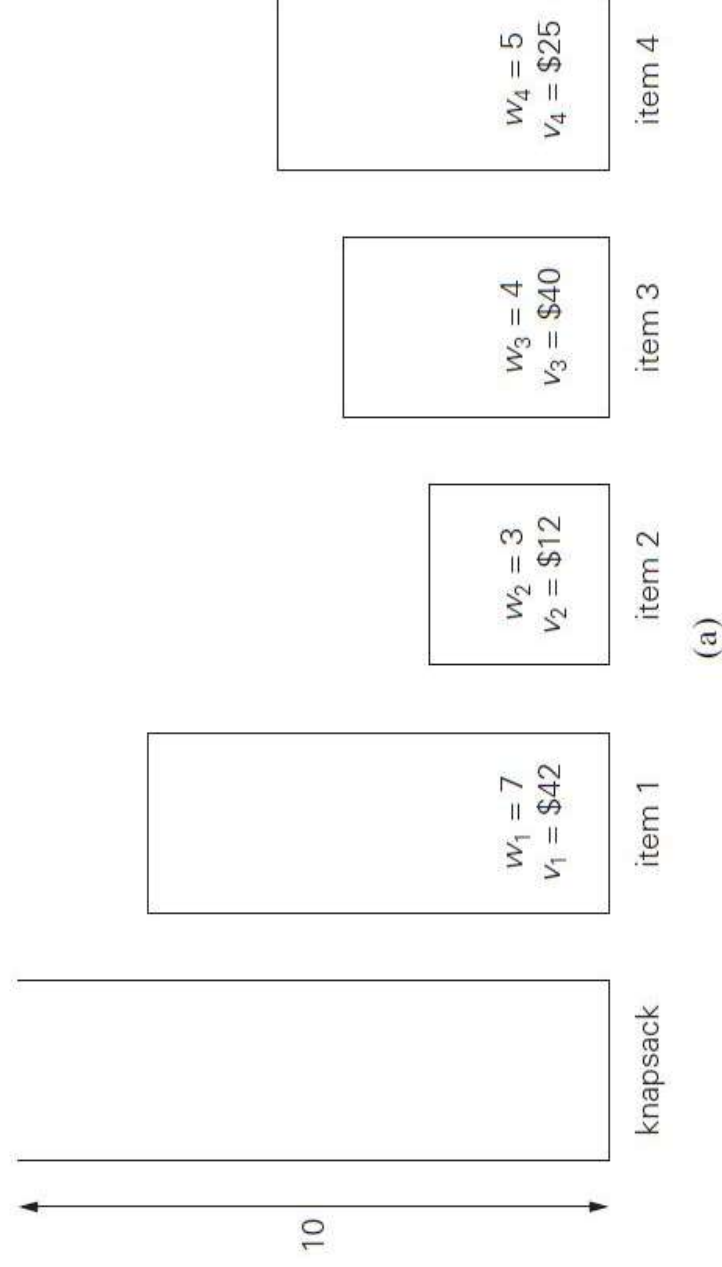
You cannot take fractions of items; you must either include an entire item or exclude it entirely.



0/1 Knapsack Problem

Activity-1 (Problem-Based Learning) (Pen and Paper)

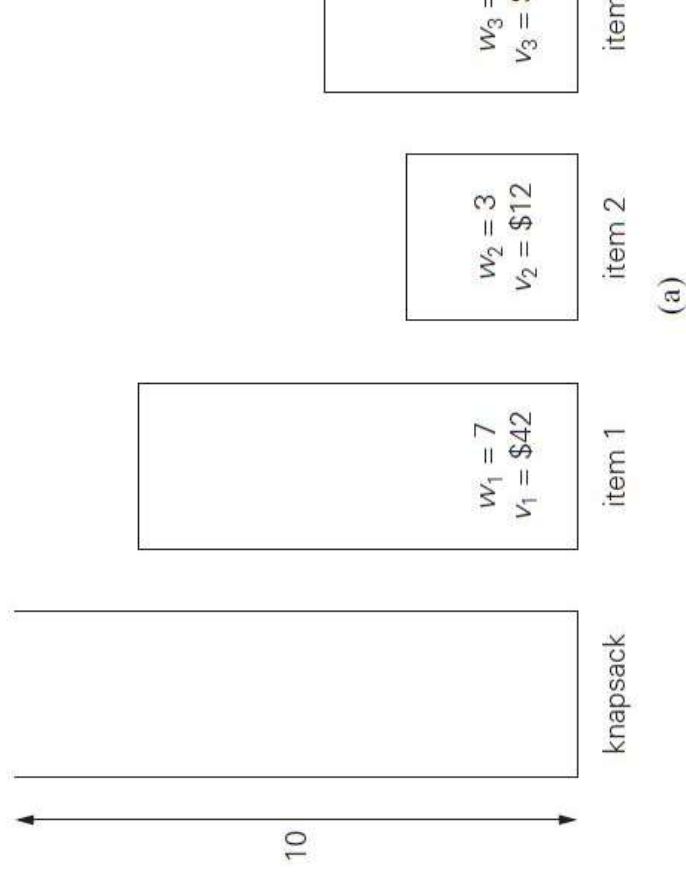
- Generate all the subsets of the set of 4 items given.
- Compute the total weight of each subset in order to identify feasible subsets the ones with the total weight not exceeding the knapsack capacity).
- Find a subset of the largest value among them.



Solution of the Activity-1

Subset	Total weight	Total value
\emptyset	0	\$0
{1}	7	\$42
{2}	3	\$12
{3}	4	\$40
{4}	5	\$25
{1, 2}	10	\$54
{1, 3}	11	not feasible
{1, 4}	12	not feasible
{2, 3}	7	\$52
{2, 4}	8	\$37
{3, 4}	9	\$65
{1, 2, 3}	14	not feasible
{1, 2, 4}	15	not feasible
{1, 3, 4}	16	not feasible
{2, 3, 4}	12	not feasible
{1, 2, 3, 4}	19	not feasible

(b)



Answer: {3,4} is the most valuable subset of items that fit into the knapsack.

0/1 Knapsack Problem

Activity-2 (Problem-Based Learning) (Pen and Paper or woodlap

- Write an **algorithm** to solve knapsack problem using brute method.
- Find its **time complexity**.

Solution of Activity-2

Algorithm:

- Generate all possible subsets of the given items.
- Compute the total weight and value for each subset.
- Discard subsets whose total weight exceeds W (capacity of knapsack).
- Select the subset with the highest total value.

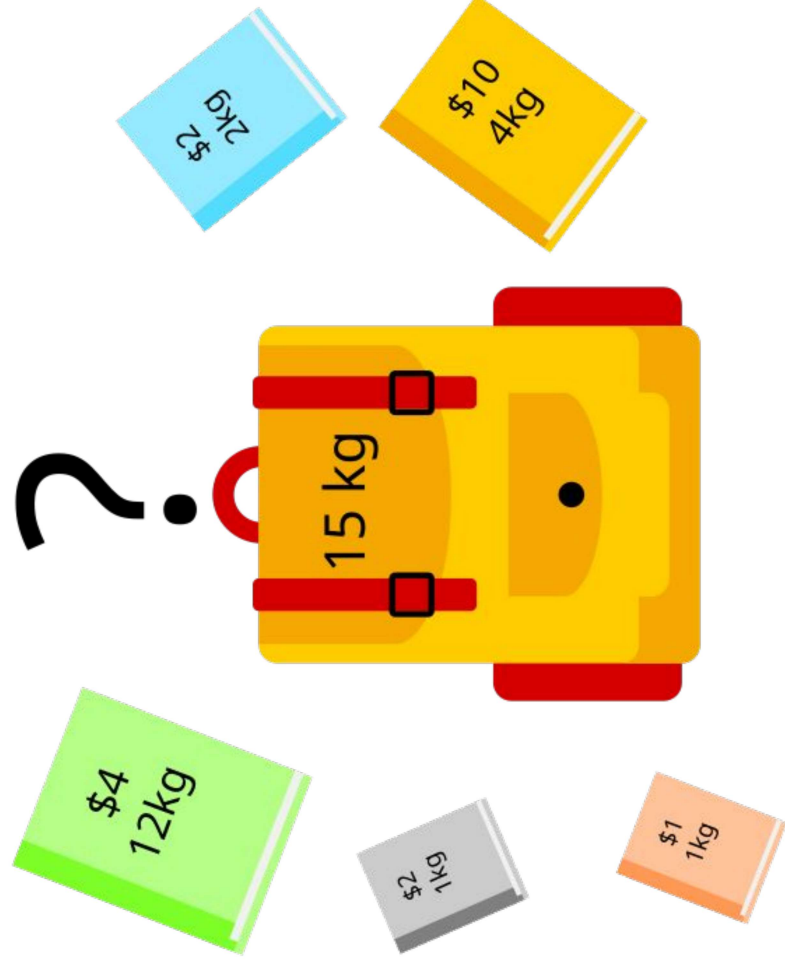
Time Complexity

- Since we generate all 2^n subsets, the time complexity is $O(2^n)$, where n is the number of items.
- This makes the brute force approach impractical for large n .

0/1 Knapsack Problem

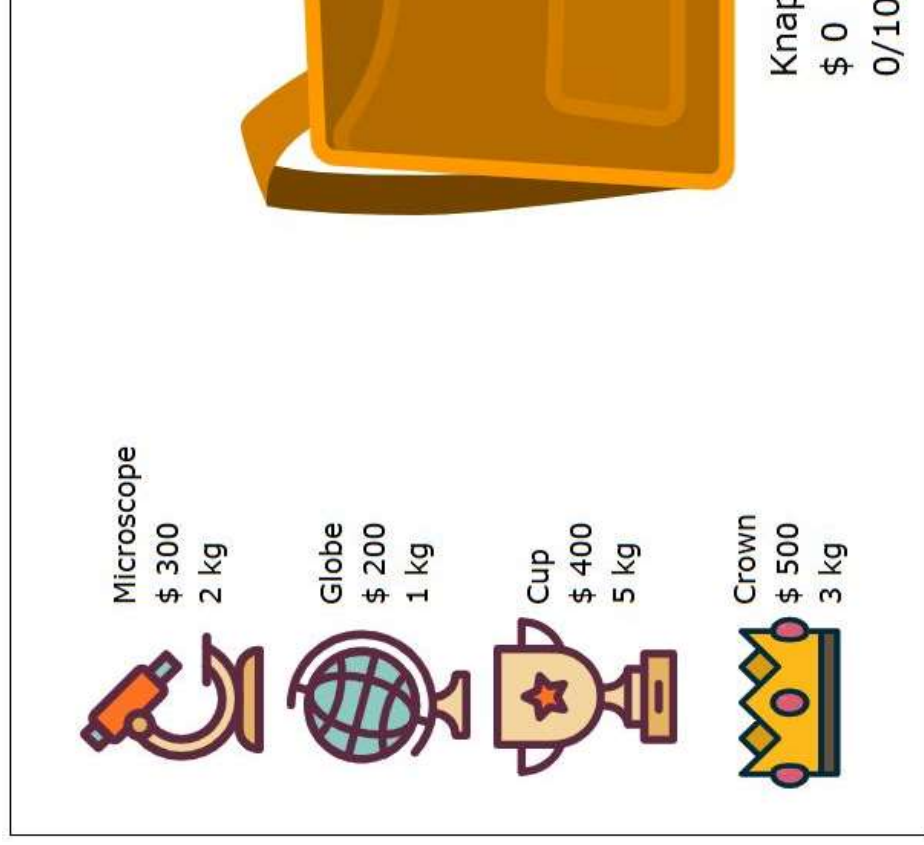
Exercise 1:

Which books should be chosen to maximize the amount of money while still keeping the overall weight under or equal to 15 kg?



Exercise 2:

Which treasures to pack to maximize the amount of money while still keeping below the bag's weight limit?



Post session activities

Everyone must attend the **post-assessment on LMS.**

In the next session, **Assignment Problem using Brute Force method** will be discussed.

What was the most interesting concept you learned today?

Any **doubts** or areas requiring further clarification?

Thank You!