

Computer Algorithms ISE 1

0/1 Knapsack Problem Visualization

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Link to GitHub Repository - [Link](#) | Link to Hosted Website - [Website](#)

What is the Knapsack Problem?

Given n items where each item has some weight and profit associated with it and also given a bag with capacity W , [i.e., the bag can hold at most W weight in it]. The task is to put the items into the bag such that the sum of profits associated with them is the maximum possible.

Where does 0/1 come in? The constraint here is we can either put an item completely into the bag or cannot put it at all [It is not possible to put a part of an item into the bag].

How the Algorithm Works (Dynamic Programming)

To solve this, we use a method called Dynamic Programming (DP) using a table where - Rows (i) represent the items we've looked at so far and columns (w) represent the available weight capacity and each cell ($DP[i][w]$) holds the best value we can get using the first i items with capacity w .

The Recurrence Relation

To fill any cell $DP[i][w]$ we look at the current item (i) and check if we take it or leave it?

1. If the item is too heavy ($w_i > w$): We must leave it. The best value is simply the best value we got without item i .

$$DP[i][w] = DP[i-1][w]$$

2. If the item fits ($w_i \leq w$): We check two options and pick the better one.

$$DP[i][w] = \max(DP[i-1][w], v_i + DP[i-1][w-w_i])$$

Visualization

I built a tool using HTML, CSS, and JavaScript to show this grid-filling process step-by-step.

0/1 Knapsack Problem using DP

Inputs

Knapsack Capacity

Items

Weight 2	Weight 3	Weight 4	Weight 5
Profit 3	Profit 4	Profit 5	Profit 8

Add ItemLoad PresetBest CaseWorst CaseClear All

Fig. 1: Input Fields with Presets, Best and Worst Case

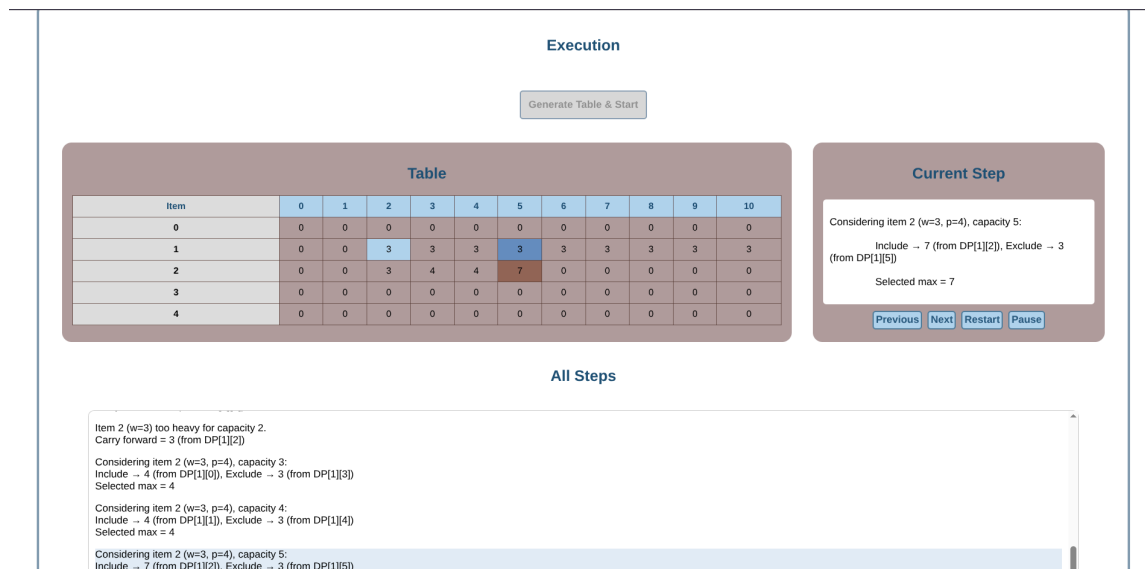


Fig. 2: Mid Execution. Showing Comparison between Options and Traversal

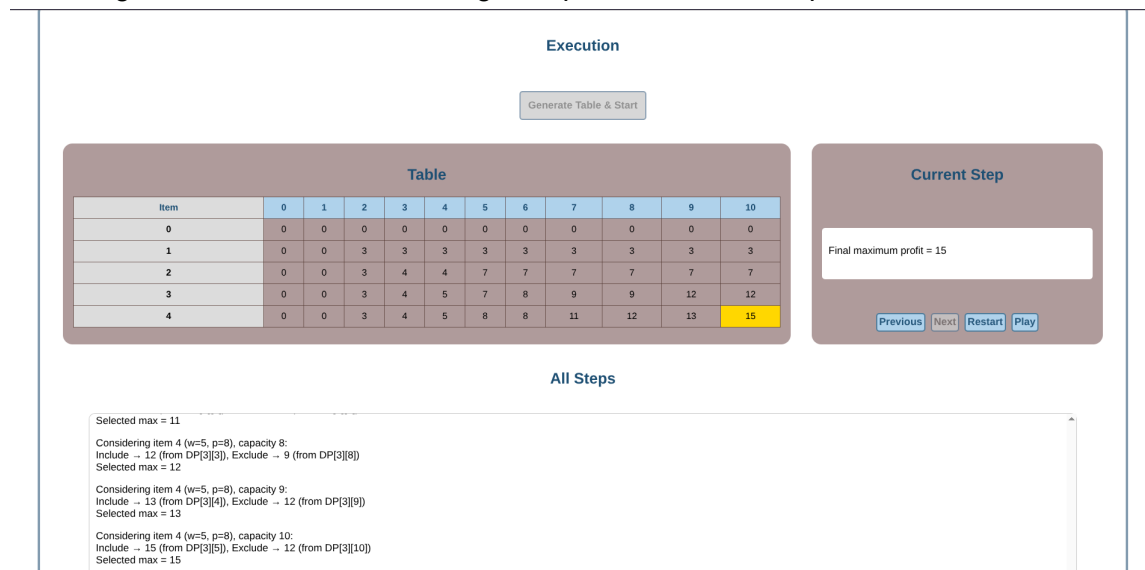


Fig. 3: Completed Execution with final result.

Complexity (How Fast It Is)

In order to evaluate, we need to traverse the DP table once. Thus, the time complexity is $O(n \cdot c)$.

Where,

n: The number of items + 1

c: The capacity of the knapsack + 1

The visualization clearly shows why the time is $O(n \cdot c)$ because you watch the program touch every single cell in the table.