Greedy Heuristic for Multidimensional Cubic Knapsack Problem

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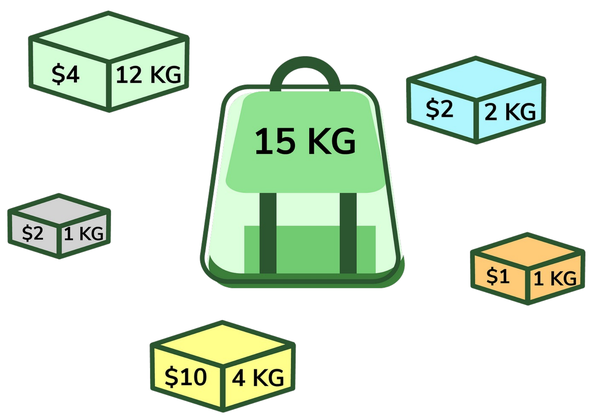
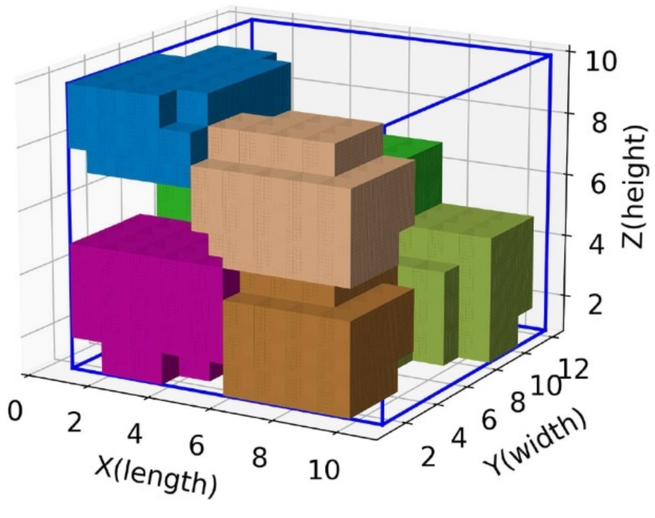
Introduction

1. What is a knapsack problem?
   - A combinatorial optimization problem where the goal is to maximize the value of items packed into a knapsack with limited weight capacity



2. What is a multidimensional cubic knapsack problem (CMKP)?
   - Multidimensional – item has weight in multiple dimensions such as the length, width, and height
   - Cubic – item has additional combined values. For example, having the green, blue, and orange, box in the knapsack can lead to an additional $5



Methods

1. Instance Generation*
   - Tested instances are generated with different size (n), linear coefficient (c), quadratic coefficient (C), cubic coefficient (D), weights (a), weight constraint (b), and density (percentage of nonzero coefficient)
2. Linearization Techniques*
   - To evaluate the effectiveness of the developed heuristics, we employed linearization techniques alongside Gurobi solver to retrieve the optimal solution given a CMKP. This allows comparison of the heuristics results in small instances
3. Notations
   a) RHS = weight untaken in the current dimension
   b) P = potential profit of an element not in knapsack computed by considering all items currently in the knapsack
4. Heuristics
   a) Standard/Naive/Constructive Greedy
      - Classic greedy that makes selection based on the bang-for-buck ratio – potential profit over weight (p/a)
   b) Destructive Greedy
      - Instead of starting with no elements, contain all elements to begin with and iteratively remove elements based on the bang-for-buck ratio
   c) Advanced Greedy
      - Creates a new combined weight evaluation p * min (RHS / a, max_items_fit)
      - The later is calculated by number of items that can fit in the knapsack starting from the lowest weight item
   d) Graduated Probe
      - Considers a set of elements from all combination of potential element
   e) High Value List Iteration Selection
      - Creates a VIP list of items based on their coefficient ratio
5. Pairwise Exchange
   - A special technique applied for each of the heuristic after it is finished.

* Not elaborated due to length concerns; Can ask the presenter for more information

Conclusion

To be finished

Results