2.6/5

Facultad de Ingeniería Mecánica y Eléctrica

Universidad Autónoma de Nuevo León

# Computational Experience with Heuristics for the Multiple Knapsack Problems ~~(MKP).~~


Team E members:

Andrés Isaac Franco Benavides 2078017

Fátima Sofía Aranda Cruz 2109524

Carlos Abraham Gallardo Treviño 1962995

Gerardo Gael Peña Cital

## 1. Introduction.

Knapsack problems are a general situation issue which come inherently by the limits of a lot of things like weight, value, number of things of a certain category needed or just simpñe personal preference as real aspects which make this issue, this makes the napsack problem a very varied issue which has a lot of ways to solve depending on the context and general needs of methods which account for their variations on a more profound manner than other cases. Thanks to this in this case we as a team will find a solution of the issue of the specific case of a multi napsack using specifically the ratio methodology of the Marcelo and Toth heuristic so that with it we can solve the issue at hand on the most approachable and functional manner.

We will start solving the problem by seeing a lot of aspects from the basic structure of a napsack problem, examples, procedure and a lot more things to attain information on the functioning of the Marcelo and Toth heuristic so we inow his advantages, nuances, disadvantages and with this can recognize how to solve cases by heuristics on a real and significant manner.

## 2. Problem description.

For the Multiple Knapsack Problem, the following variables are known and needed in order to get a feasible solution (Marcelo & Toth, 1990):

- Quantity of items ($n$).
- Quantity of knapsacks ($m \leq n$)
- Profit of item j ($p_j$).
- Weight of item ($W_j$).
- Capacity of Knapsack i ($C_i$).

Based on these variables, decisions will be made regarding which items to add to certain knapsack, considering that each knapsack has a different capacity and each item has a different value, in order to find the assigment of items to knapsacks that maximizes the total value.

However, this process is limited by the following constraints:

- Each item can be allocated to at most one knapsack.
- The knapsack capacity cannot be exceeded.

Likewise, this will be achieved by following the next objective function (Lalami et al., 2012):

$$maximise: \sum_{i=1}^{m}\sum_{j=1}^{n} p_j x_{ij}$$

In which N represents the number of items, M the number of knapsacks, $p_j$ is the value of item j and $X_{ij}$ is a binary decision variable that indicates whether the item j is selected.

## 3. Problem example.

An example in real life that can be modeled using the Multiple Knapsack Problem is the distribution of goods by a logistics company to various delivery trucks.

Here's how the variables and constraints could apply:

- Quantity of items: Represents the different types of goods that need to be distributed.
- Quantity of knapsacks (delivery trucks): Represents the number of available trucks for distribution.
- Profit of item j (pj): Represents the value or importance of each type of goods.
- Weight of item (Wj): Represents the physical weight or volume of each type of goods.
- Capacity of Knapsack i (Ci): Represents the maximum weight or volume each truck can carry.

The objective would be to maximize the total value of goods distributed while ensuring that each truck doesn't exceed its capacity and that each type of goods is allocated to only one truck.

The decision variables (Xij) would indicate whether a specific type of goods is loaded onto a particular truck.

By optimizing the assignment of goods to trucks while considering their values and the capacity constraints of each truck, the logistics company can efficiently distribute goods to maximize profit and ensure timely deliveries.

## References.

Lalami, M. E., Elkihel, M., Baz, D. E., & Boyer, V. (2012). A procedure-based heuristic for 0-1 Multiple Knapsack Problems. *International journal of mathematics in operational research*, *4*(3), 214. https://doi.org/10.1504/ijmor.2012.046684

Martello, S., & Toth, P. (1990). *Knapsack problems: Algorithms and computer implementations*. John Wiley & Sons.