Dynamic optimization exercise NO.1

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1 knapsack problem

According to Wikipedia The knapsack problem is the following problem in combinatorial optimization:

Given a set of items, each with a weight and a value, determine which items to include in the collection so that the total weight is less than or equal to a given limit and the total value is as large as possible.

Inputs

- Capacity: maximum capacity of our backpack.
- Wi: weight of each item.
- Vi: value of each item.

sample inputs:

```
Capacity = 106
weight = {'Bag1':300, 'Bag2':1, 'Bag3':200,
          'Bag4':100, 'Bag5':10, 'Bag6':54}

value = {'Bag1':4000, 'Bag2':5000, 'Bag3':5000,
         'Bag4':2000, 'Bag5':1000, 'Bag6':283}
```

Output

- Xi: The decision to take or not take any item.
- Eventual weight and value of Backpack.

```
sample oututs:
Bag1 : 0.0
   Bag2 : 1.0
   Bag3 : 0.0
   Bag4 : 0.0
```

```
    Bag5  :  1.0
    Bag6  :  1.0
objective:  8834.0
```

`Modeling the problem`

$$max \sum_{i=1}^{n} Vi \cdot Xi$$
$$subjectto:$$
$$\sum_{i=1}^{n} Wi \cdot Xi < Capacity$$
$$Xi > 0$$

Implementation with python

```
M.value = Objective(expr=sum(value[i]*M.x[i]
                    for i in M.ITEMS),sense=maximize)
M.weight = Constraint(expr=sum(weight[i]*M.x[i]
                      for i in M.ITEMS) <=Capacity)
```

2 UFLP

The UFLP (Uncapacitated Facility Location Problem) or Facility Coverage Problem is a problem in which a number of facilities must be placed in different locations and the cost of this placement must be minimized. In this problem, each facility can cover one or multiple customers, and each customer must be covered by one facility.

Problem formulation: In this problem, a set F of facilities and a set C of customers are given. Additionally, fi represents the installation cost of facility i , and cij represents the cost of covering customer j by facility i . The objective is to minimize the total cost of installation and coverage of facilities.

Constraints:

Each customer must be covered by at least one facility: Each facility can only be installed once: Data file: The required data file for this code includes two matrices. The first matrix represents the installation costs of facilities, and the second matrix represents the cost of covering each customer by each facility. Additionally, the number of facilities and customers is specified in this file.

```
nFacilities = 3;
nCustomers = 4;
FacilityFixedCosts = [1 2 3];
CustomerCosts = [ [1 2 3 4], [2 3 4 1], [3 4 1 2] ];
```

Explanation:

In this code, the variable nFacilities represents the number of facilities, and the variable nCustomers represents the number of customers.

Additionally, the matrix FacilityFixedCosts includes the installation costs of facilities, and the matrix CustomerCosts includes the cost of covering each customer by each facility. Finally, the constraints of the problem are implemented using the sum and forall functions.