# **M2 - Big Data Management and Analytics**

### **Decision Modelling – Practical 2 – Linear Programming and Preferences**

#### Rishika Gupta

This document adds some comments to the code of the practical works.

### Exercise 1: Toy Manufacturing Problem

### Solution:

To solve this problem using linear programming, the aim is to maximize the profit generated by manufacturing toys A and B. First, defining the decision variables, objective function, and constraints.

Decision Variables:

Let ***“a”*** be the number of toys A that will be manufactured, and ***“b”*** be the number of toys B to be manufactured.

Objective Function:

The profit generated from manufacturing toys A and B can be calculated using the given selling prices and resource usage:

***Profit = (25€ x a) + (20€ × b)***

Constraints:

* Resource constraint: The total resource units used by toys A and B should not exceed the available 2000 units:

***20a + 12b ≤ 2000***

* Time constraint: The total production time for toys A and B should not exceed the available working hours of 9 hours/day, which is 9 x 60, i.e. 540 minutes/day (converting hours to minutes):

***5a + 5b ≤ 540***

* Non-negativity constraint: The number of toys manufactured cannot be negative:

**a ≥ 0, b ≥ 0**

Now, solving this linear programming problem step by step.

Step 1: Formulate the Objective Function:

***Maximize Profit = 25a + 20b***

Step 2: Formulate the Constraints:

***20a + 12b ≤ 2000***

***5a + 5b ≤ 540***

***a ≥ 0, b ≥ 0***

Step 3: Solve using a Linear Programming:

Using linear programming in Python (PuLP package) to find the values of a and b that maximize the profit function,

Profit = 25a + 20b subject to the constraints.

The optimal values of a and b obtained from the program are toy A = 88 units and toy B = 20 units in order to maximize the profits while adhering to the given constraints, with the maximum profit as 25\*88 + 20\*20 = 2600 €.

### Exercise 2: Mr. Doe Visits Paris

Mr. Doe’s research information (regarding every monument’s duration to visit, price and appreciation received is captured in the data in the form:

**Monument\_Name: [duration\_value, price\_value, appreciation\_value]**

Function maximize\_visit\_paris():

* I/P: data, PuLP problem
* O/P: list of monuments to visit
* Logic: using the PuLP’s solved problem, prints maximum objective value and optimal values for the other variables associated – i.e., total duration and price for visiting the same.

Function is\_identical():

* I/P: two lists
* O/P: boolean value
* Logic: performing a check on the two lists to see if they are identical or not.

Function create\_linear\_problem(param):

* I/P: problem name, if not provided “Mr\_Doe\_Visits\_Paris” will be used as default
* O/P: PuLP problem
* Logic: Created problem, added objective function and constraints (price and duration)

### Question 1:-

**ListVisit1:**

It is the generic objective function subjected to constraints of price and duration.

The list thus obtained is named as ListVisit1.

### Question 2:-

**Preference 1:**

The logic used here is if Mr. Doe visits either of the places, then the value of the joint variable will be 2.

If he visits neither of the places, then the value of the joint variable will be 0. Thus, deducing that the twice the value of the joint variable = sum of the values of each variable.

The list thus obtained is named as ListVisit2\_Preference1.

**Preference 2:**

The logic here is since Mr. Doe visits both TE and CA, thus the sum of their variables will be 2.

The list thus obtained is named as ListVisit2\_Preference2.

**Preference 3:**

The logic here is if Mr. Doe visits CN then SC will not be visited, thus the sum of their variables will be less than equal to 1.

The list thus obtained is named as ListVisit2\_Preference3.

**Preference 4:**

The logic here is since Mr. Doe visits TM, thus the value of the variable will be 1.

The list thus obtained is named as ListVisit2\_Preference4.

**Preference 5:**

The logic used here is if Mr. Doe visits either of the places, then the value of the joint variable will be 2. If he visits neither of the places, then the value of the joint variable will be 0. Thus, deducing that the twice the value of the joint variable = sum of the values of each variable. The list thus obtained is named as ListVisit2\_Preference5.

**Questions 2(b) – 2(m):**

* To answer questions 2(b) till 2(l) -> the lists are created within the solution with the naming convention – ListVisit2\_b, ListVisit2\_c, etc.
* Next, to test question 2(m), all the ListVisit2\_b till ListVisit2\_l are tested using the is\_identical() function.

### Question 3:-

Firstly, the values of duration, price and appreciation are extracted from the data dictionary.

Also, the values of appreciation are negated.

Since, in this question, we are finding the better rankings =>

* Duration: less time = better
* Price: less cost = better
* Appreciation: high rating = better (thus negated)

Next, each pair of ranking categories is run for Kendall’s Tau and Spearman.

* **Duration and Price**:
  + Kendall Tau: 0.606 (positive correlation)
  + Spearman: 0.741 (positive correlation)
  + Implication: There is a strong positive correlation between the duration and price. As the duration increases, the price tends to increase as well, that means the rankings are positively closely related.
* **Duration and Appreciation**:
  + Kendall Tau: -0.152 (negative correlation)
  + Spearman: -0.206 (negative correlation)
  + Implication: There is a weak negative correlation between the duration and appreciation. A longer duration might be associated with slightly lower levels of appreciation, that means the rankings are negatively sparsely related.
* **Price and Appreciation**:
  + Kendall Tau: 0.085 (positive correlation)
  + Spearman: 0.134 (positive correlation)
  + Implication: There is a weak positive correlation between the price and appreciation. Higher prices might be associated with slightly higher levels of appreciation, though the correlation is not strong, that means that the rankings are positively sparsely related.
* In summary:
  + Duration and price are strongly positively correlated.
  + Duration and appreciation are weakly negatively correlated.
  + Price and appreciation are weakly positively correlated.