(Two Products) In Arizona, a beverage company produces orange juice and apple juice on two machines. The number of hours of machine time and labor depends on the machine and product as shown in the file P03\_38.xlsx. The cost of producing a unit of each product depends on which machine produces it. These unit costs also appear in the same file. Each month, there are 200 hours available on each of the two machines, and there are 400 labor hours available total. Unfortunately, the new Labor Standards Act was enacted one month age, which regulated the total labor hours from 500 hours to 380 hours per month. This month at least 250 units of product 1 and at least 170 units of product 2 must be produced. Also, at least half of the product 1 requirement must be produced on machine 2, and at least half of the product 2 requirement must be produced on machine 1. Determine how the company can minimize the cost of meeting this month’s requirements.

**Discussion: -**

It is similar to the one for the smaller product mix model, but it is not the same. It might not be immediately obvious what the decision variables should be for this model. You might think that the beverage company simply needs to decide how many products of each model to produce. However, because of the two machines, this is not enough information. The company must also decide how many of each model to produce on each machine. This is the type of reasoning you must go through to determine the appropriate decision variables for any LP model. You must choose the number of products of each model to produce on each machine. This choice determines the machine hours, labor hours, unit cost for product and machine combination. You must also meet the labor hours constraint. If you can put all your inputs in below format (Combination of product & machine), it will be easy to solve the problem. Let’s us assume ‘i’ be the index for product and ‘j’ be the index for machines. Machine hours required to produce product ‘i’ using machine ‘j’ will be $M\_{ij}$. $M\_{12}$ indicates the machine hours required to produce product 1 using machine 2, which is 0.8.



Coming to Objective is to minimize the production cost. Production cost is nothing, but the product of Unit cost and products produced. Here, in this problem we have 2 types of products and 2 types of machine, so your total production cost is sum-product of “Unit cost to produce product i on machine j” and “Number of products i produced on machine j”.

**Mathematical Model: - Parameters (Inputs):**

$$i,j \in 1,2, \left(i:Index for type of juice, j:Index for type of machines\right)$$

$$M\_{ij}:Machine hours required to produce juice^{'}on machine 'j'$$

$$L\_{ij}:Labor hours required to produce juice^{'}on machine 'j'$$

$$C\_{ij}:Unit cost to produce juice^{'}on machine 'j'$$

$$D\_{i}:Demand to produce juice 'i'$$

$$M\_{j}:Machine hours available for machine 'j'$$

$$L:Total Labor hour available$$

$$D\_{ij}:Demand to produce juice^{'}on machine 'j'$$

**Decision Variables:**

$$X\_{ij}:Number of juice^{'}produced on machine 'j'$$

**Objective:**

$$Minimize Total Cost= \sum\_{i=1}^{2}\sum\_{j=1}^{2}X\_{ij}\*C\_{ij}$$

**Constraints:**

$X\_{ij}\geq 0$ (1) Non Negative constraint

$\sum\_{i=1}^{2}\left(X\_{ij}\*M\_{ij}\right)\leq M\_{j} for j \in \left\{1,2\right\}$ (2) Machine hours constraint

$\sum\_{i=1}^{2}\sum\_{j=1}^{2}(X\_{ij}\*L\_{ij})\leq L$ (3) Labor hours constraint

$\sum\_{i=1}^{2}X\_{ij}\leq D\_{j} for i\in \left\{1,2\right\}$ (4) Production Demand constraint

$X\_{ij}\geq D\_{ij}$ (5) Demand to produce juice ‘i’ on machine ‘j’

**Excel Implementation:**

Please find the attached spreadsheet for solution.