Assignment\_3

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AED\_data = matrix(c(20,14,25,400,100,12,15,14,300,125,10,12,15,500,150,80,90,70,"-","-"),ncol = 5, byrow = TRUE)  
colnames(AED\_data)= c ("WH1","WH2","WH3","production cost","production capacity")  
rownames(AED\_data)=c("Plant\_A","Plant\_B","Plant\_c","monthly demand")  
AED\_data=as.table(AED\_data)  
AED\_data

## WH1 WH2 WH3 production cost production capacity  
## Plant\_A 20 14 25 400 100   
## Plant\_B 12 15 14 300 125   
## Plant\_c 10 12 15 500 150   
## monthly demand 80 90 70 - -

#objective function

$$TC\hspace{0.1cm}=420x\_{11}+\hspace{0.1cm}414x\_{12}+\hspace{0.1cm}425x\_{13}+\hspace{0.1cm}312x\_{21}+\hspace{0.1cm}315x\_{22}+\hspace{0.1cm}314x\_{23}+\hspace{0.1cm}510x\_{31} +\hspace{0.1cm}512x\_{32}+\hspace{0.1cm}515x\_{33}$$

library(lpSolve)  
AED\_2 = matrix(c(420,414,425,100,"p1",312,315,314,125,"p2",510,512,515,150,"p3",80,90,70,250,"-","q1","q2","q3"),ncol = 5,nrow = 5,byrow = TRUE)

## Warning in matrix(c(420, 414, 425, 100, "p1", 312, 315, 314, 125, "p2", : data  
## length [23] is not a sub-multiple or multiple of the number of rows [5]

colnames(AED\_2)=c("WH1","WH2","WH3","production capacity","dual\_supply")  
rownames(AED\_2)=c("Plant\_A","Plant\_B","Plant\_c","monthly demand","dual-demand")  
AED\_2= as.table(AED\_2)  
AED\_2

## WH1 WH2 WH3 production capacity dual\_supply  
## Plant\_A 420 414 425 100 p1   
## Plant\_B 312 315 314 125 p2   
## Plant\_c 510 512 515 150 p3   
## monthly demand 80 90 70 250 -   
## dual-demand q1 q2 q3 420 414

# dual constraints

$$ \hspace{.1cm}X\_{11}+X\_{12}+X\_{13}\le100$$

$$ \hspace{.1cm}X\_{21}+X\_{22}+X\_{23}\le125$$

$$ \hspace{.1cm}X\_{31}+X\_{32}+X\_{33}\le150$$

#3.demand constraint

$$ \hspace{.1cm}X\_{11}+X\_{11}+X\_{11}\ge80$$

$$ \hspace{.1cm}X\_{12}+X\_{22}+X\_{32}\ge90$$

$$ \hspace{.1cm}X\_{13}+X\_{23}+X\_{33}\ge70$$

#non-negativity of variables

$$ \hspace{.1cm}x\_{ij}\ge0\hspace{0.1cm}where\hspace{0.1cm}i=1,2,3\hspace{0.1cm}and\hspace{0.1cm}j=1,2,3$$

I took on the transportation issue in the R programming language, which is intrinsically unbalanced because of an imbalance between supply and demand. In the fourth column of the cost matrix, I included a “dummy” variable to account for the case where demand is 10 units short. The dummy variable has a demand of 10 units and a transportation cost of 0. Even if the supply and demand limitations in the mathematical model are originally unbalanced, this modification helps to assure that they are.

# AEDs\_Costs matrix  
AEDs\_Costs <- matrix(c(420,414,425,0,  
312,315,314,0,  
510,512,515,0),ncol = 4,byrow=TRUE)  
## Set the names of the rows (constraints) and columns (decision variables)  
colnames(AEDs\_Costs) <- c("WareHouse1", "WareHouse2", "WareHouse3","Dummy")  
rownames(AEDs\_Costs) <- c("Plant A", "Plant B", "Plant C")  
AEDs\_Costs

## WareHouse1 WareHouse2 WareHouse3 Dummy  
## Plant A 420 414 425 0  
## Plant B 312 315 314 0  
## Plant C 510 512 515 0

# performing signs and right hand side

row.signs = rep("<=",3)  
row.rhs = c(100,125,150)  
col.signs = rep(">=",4)  
col.rhs = c(80,90,70,10)

#solve lp model

lptrans = lp.transport(AEDs\_Costs,"min",row.signs,row.rhs,col.signs,col.rhs)

lptrans$solution

## [,1] [,2] [,3] [,4]  
## [1,] 10 90 0 0  
## [2,] 55 0 70 0  
## [3,] 15 0 0 10

lptrans$objval

## [1] 88250

#Objective function  
obj <- c(420, 414, 425, 312, 315, 314, 510, 512, 515)  
  
# Coefficients matrix for constraints (lhs)  
lhs <- matrix(c(1, 1, 1, 0, 0, 0, 0, 0, 0,  
 0, 0, 0, 1, 1, 1, 0, 0, 0,  
 0, 0, 0, 0, 0, 0, 1, 1, 1,  
 1, 0, 0, 1, 0, 0, 1, 0, 0,  
 0, 1, 0, 0, 1, 0, 0, 1, 0,  
 0, 0, 1, 0, 0, 1, 0, 0, 1), nrow = 6, byrow = TRUE)  
  
# Right-hand side values for constraints (rhs)  
rhs <- c(100, 125, 150, 80, 90, 70)  
  
# Define the direction of inequalities (equalities)  
dir <- c("<=", "<=", "<=", "=", "=", "=")  
  
# Solve the linear programming problem  
lp=lp("min", obj, lhs, dir, rhs)  
  
# Extract the solution  
solution <- lp$solution  
  
# Print the optimal solution  
print(solution)

## [1] 10 90 0 55 0 70 15 0 0

**The interpretation of the dual variables**

For the supply constraints(1,2,3): Dual variables indicate the marginal cost of producing an additional unit of the product at each plant. A higher dual variable value for a plant implies that increasing production capacity at that plant would incur a higher cost compared to the other plants.

For the demand constraints(1,2,3): Dual variables represent the marginal revenue or profit obtained by supplying an additional unit of the product to each warehouse. A higher dual variable value for a warehouse suggests that fulfilling additional demand at that warehouse would yield a higher profit compared to the other warehouses.