Integer Programming

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AP is a shipping service that guarantees overnight delivery of packages in the continental US. The company has various hubs at major cities and airports across the country. Packages are received at hubs, and then shipped to intermediate hubs or to their final destination.

The manager of the AP hub in Cleveland is concerned about labor costs, and is interested in determining the most effective way to schedule workers. The hub operates seven days a week, and the number of packages it handles varies from one day to another. The table below provides an estimate of the number of workers needed each day of the week.

#Loading lpSolveAPI package  
library(lpSolveAPI)  
getwd()

## [1] "/Users/nikhilreddya/Documents/assignments/QMM/assignment 6"

#setting working directory  
setwd("/Users/nikhilreddya")  
#loading the lp file  
My\_table <- read.lp("My\_table.lp")  
My\_table

## Model name:   
## x1 x2 x3 x4 x5 x6 x7   
## Minimize 775 800 800 800 800 775 750   
## R1 0 1 1 1 1 1 0 >= 18  
## R2 0 0 1 1 1 1 1 >= 27  
## R3 1 0 0 1 1 1 1 >= 22  
## R4 1 1 0 0 1 1 1 >= 26  
## R5 1 1 1 0 0 1 1 >= 25  
## R6 1 1 1 1 0 0 1 >= 21  
## R7 1 1 1 1 1 0 0 >= 19  
## Kind Std Std Std Std Std Std Std   
## Type Int Int Int Int Int Int Int   
## Upper Inf Inf Inf Inf Inf Inf Inf   
## Lower 0 0 0 0 0 0 0

#The number of employees required on each day of the week is estimated in the table below.  
Workers\_Required <-matrix(c("Sunday","Monday","Tuesday","Wednesday","Thursday","Friday","Saturday",  
18,27,22,26,25,21,19),ncol=2,byrow = F)  
colnames(Workers\_Required) <- c("Day\_of\_the\_week", "Workers\_Required")  
as.table(Workers\_Required)

## Day\_of\_the\_week Workers\_Required  
## A Sunday 18   
## B Monday 27   
## C Tuesday 22   
## D Wednesday 26   
## E Thursday 25   
## F Friday 21   
## G Saturday 19

Package handlers at AP are guaranteed a five-day work week with two consecutive days off. The base wage for the handlers is $750 per week. Workers working on Saturday or Sunday receive an additional $25 per day. The possible shifts and salaries for package handlers are:

DayOffs\_wages\_emp <- matrix(c(1,2,3,4,5,6,7,  
 "Sunday and Monday","Monday and Tuesday","Tuesday and Wednesday",  
"Wednesday and Thursday","Thursday and Friday","Friday and Saturday","Saturday and Sunday",  
 "$775","$800","$800","$800","$800","$775","$750"),ncol=3,byrow=F)  
colnames(DayOffs\_wages\_emp) <- c("Shift", "Days\_Off", "Wage")  
as.table(DayOffs\_wages\_emp)

## Shift Days\_Off Wage  
## A 1 Sunday and Monday $775  
## B 2 Monday and Tuesday $800  
## C 3 Tuesday and Wednesday $800  
## D 4 Wednesday and Thursday $800  
## E 5 Thursday and Friday $800  
## F 6 Friday and Saturday $775  
## G 7 Saturday and Sunday $750

solve(My\_table)

## [1] 0

get.objective(My\_table)

## [1] 25675

Total cost = $25675

get.variables(My\_table)

## [1] 2 4 5 0 8 1 13

The variables are labeled from x1, x2…….x7 where,

\*x1 = Number of workers assigned to shift 1 = 2

\*x2 = Number of workers assigned to shift 2 = 4

\*x3 = Number of workers assigned to shift 3 = 5

\*x4 = Number of workers assigned to shift 4 = 0

\*x5 = Number of workers assigned to shift 5 = 8

\*x6 = Number of workers assigned to shift 6 = 1

\*x7 = Number of workers assigned to shift 7 = 13

Hence, the workers availabe for each day is

Available <- matrix(c(0,4,5,0,8,1,0,0,0,5,0,8,1,13,2,0,0,0,8,1,13,2,4,0,0,8,1,13,2,4,5,0,0,1,13,2,3,4,0,0,0,13,2,4,5,0,8,0,0), ncol=7,byrow=TRUE)  
colnames(Available)<- c("Shift1", "Shift2", "Shift3", "Shift4", "Shift5", "Shift6", "Shift7")  
row.names(Available) <- c('Sunday', 'Monday', 'Tuesday','Wednesda','Thursday','Friday','Saturday')  
Available

## Shift1 Shift2 Shift3 Shift4 Shift5 Shift6 Shift7  
## Sunday 0 4 5 0 8 1 0  
## Monday 0 0 5 0 8 1 13  
## Tuesday 2 0 0 0 8 1 13  
## Wednesda 2 4 0 0 8 1 13  
## Thursday 2 4 5 0 0 1 13  
## Friday 2 3 4 0 0 0 13  
## Saturday 2 4 5 0 8 0 0

rowSums(Available)

## Sunday Monday Tuesday Wednesda Thursday Friday Saturday   
## 18 27 24 28 25 22 19