Module 11 - Integer Programming

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AP shipping company’s problem formulation:

//OBJECTIVE FUNCTION MIN: 775X1 + 800X2 + 800X3 + 800X4 + 800X5 + 775X6 + 750X7;

// CONSTRAINS WORKERS REQUIRED ON SUNDAY CONSTRAINTS : X2 + X3 + X4 + X5 + X6 >= 18; WORKERS REQUIRED ON MONDAY CONSTRAINTS : X3 + X4 + X5 + X6 + X7 >= 27; WORKERS REQUIRED ON TUESDAY CONSTRAINTS : X1 + X4 + X5 + X6 + X7 >= 22; WORKERS REQUIRED ON WEDNESDAY CONSTRAINTS : X1 + X2 + X5+ X6 + X7 >= 26; WORKERS REQUIRED ON THURSDAY CONSTRAINTS : X1 + X2 + X3 + X6 + X7 >= 25; WORKERS REQUIRED ON FRIDAY CONSTRAINTS : X1 + X2 + X3 + X4 + X7 + >= 21; WORKERS REQUIRED ON SATURDAY CONSTRAINTS : X1 + X2 + X3 + X4 + X5 >= 19;

// INTEGERS X1,X2,X3,X4,X5,X6,X7>=0 ;

X1 : workers assigned for shift 1 = 2; X2 : workers assigned for shift 2 = 4; X3 : workers assigned for shift 3 = 5; X4 : workers assigned for shift 4 = 0; X5 : workers assigned for shift 5 = 8; X6 : workers assigned for shift 6 = 1; X7 : workers assigned for shift 7 = 13;

*Reading the lp file:*

library(lpSolveAPI)  
AP\_Shipping <- read.lp("shipping.lp")  
AP\_Shipping

## 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

*lp model solution:*

solve(AP\_Shipping) #Optimal solution found

## [1] 0

*How much did everything cost in total?*

get.objective(AP\_Shipping) #The minimum wage expense is $25,675

## [1] 25675

*How many staff are accessible each day?*

get.variables(AP\_Shipping)

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

*The number of workers available for each shift is as follows:*

workers <- 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)  
row.names(workers) <- c('SUN','MON','TUE','WED','THUR','FRI','SAT')  
colnames(workers)<- c('SHIFT-1','SHIFT-2','SHIFT-3','SHIFT-4','SHIFT-5','SHIFT-6','SHIFT-7')  
workers

## SHIFT-1 SHIFT-2 SHIFT-3 SHIFT-4 SHIFT-5 SHIFT-6 SHIFT-7  
## SUN 0 4 5 0 8 1 0  
## MON 0 0 5 0 8 1 13  
## TUE 2 0 0 0 8 1 13  
## WED 2 4 0 0 8 1 13  
## THUR 2 4 5 0 0 1 13  
## FRI 2 3 4 0 0 0 13  
## SAT 2 4 5 0 8 0 0

*The number of workers needed each day to reduce total wage expenses:*

rowSums(workers)

## SUN MON TUE WED THUR FRI SAT   
## 18 27 24 28 25 22 19