QuantModelling: Assignment 10

#Title - 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.

- #Xi = the number of workers assigned to shift i, i=1 ,7

Min 775X1 +800X2 +800X3 +800X4 +800X5 +775X6 +750X7

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```
  X2+ X3+ X4+ X5+ X6     >= 18 } Sunday

      X3+ X4+ X5+ X6+ X7 >= 27 } Monday
```

X1+ X4+ X5+ X6+ X7 >= 22 }Tuesday
X1+ X2+ X5+ X6+ X7 >= 26 } Wednesday
X1+ X2+ X3+ X6+ X7 >= 25 } Thursday
X1+ X2+ X3+ X4+ X7 >= 21 } Friday
X1+ X2+ X3+ X4+ X5 >= 19 } Saturday
Xi >= 0 and integer for all i

Min 775X1 +800X2 +800X3 +800X4 +800X5 +775X6 +750X7

Constraints:

```
X2+ X3+ X4+ X5+ X6     >= 18 } Sunday

    X3+ X4+ X5+ X6+ X7 >= 27 } Monday
```

X1+ X4+ X5+ X6+ X7 >= 22 }Tuesday
X1+ X2+ X5+ X6+ X7 >= 26 } Wednesday
X1+ X2+ X3+ X6+ X7 >= 25 } Thursday
X1+ X2+ X3+ X4+ X7 >= 21 } Friday
X1+ X2+ X3+ X4+ X5 >= 19 } Saturday
Xi >= 0 and integer for all i

where

X1 = shift 1 with Sunday and Monday off

X2 = shift 2 with Monday and Tuesday off

X3 = shift 3 with Tuesday and Wednesday off

X4 = shift 4 with Wednesday and Thursday off

X5 = shift 5 with Thursday and Friday off

X6 = shift 6 with Friday and Saturday off

X7 = shift 7 with Saturday and Sunday off

#To find the constraint value for Profit, we need to first run the lp for it.

```
library(lpSolve)
library(lpSolveAPI)
y <- read.lp("ass10.lp")
y
```

```
Model name:
            X1   X2   X3   X4   X5   X6   X7
Minimize   775  800  800  800  800  775  750
Sunday       0    1    1    1    1    1    0  >=  18
Monday       0    0    1    1    1    1    1  >=  27
Tuesday      1    0    0    1    1    1    1  >=  22
Wednesday    1    1    0    0    1    1    1  >=  26
Thursday     1    1    1    0    0    1    1  >=  25
Friday       1    1    1    1    0    0    1  >=  21
Saturday     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
```

Solving the problem to get objective function.

```
solve(y)
```

```
## [1] 0
```

```
get.objective(y)
```

```
## [1] 25675
```

#Our Objective function is: 25675. #Let's look at the variables to understand what this means.

```
get.variables(y)
```

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

What this shows is:

#X1 = shift 1 with Sunday and Monday off = 2 #X2 = shift 2 with Monday and Tuesday off = 4 #X3 = shift 3 with Tuesday and Wednesday off = 5 #X4 = shift 4 with Wednesday and Thursday off = 0 #X5 = shift 5 with Thursday and Friday off = 8 #X6 = shift 6 with Friday and Saturday off = 1 #X7 = shift 7 with Saturday and Sunday off = 13

Our objective function = 2x775 + 4x800 + 5x800 + 8x800 + 1X775 + 13x750 = 25675.

The minimum cost that we can spend on salaries is 25675.