

Assignment Integer programming

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2022-11-19

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

```
library("lpSolveAPI")
```

```
#Loading the lp file
```

```
ap <- read.lp("ap.lp")
print(ap)
```

```
## 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
```

```
#An estimate of the number of workers needed each day of the week. DWR - Day wise worker required
```

```
DWR <- matrix(c("Sunday","Monday","Tuesday","Wednesday","Thursday","Friday","Saturday",
18,27,22,26,25,21,19),ncol=2,byrow = F)
```

```
colnames(DWR) <- c("Day_of_the_week", "Workers_Required")
```

```
as.table(DWR)
```

```
## 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- **DOW- Day off wage**

```
DOW<- matrix(c(1,2,3,4,5,6,7,
               "Sunday and Monday","Monday and Tuesday","Tuesday and Wednesday","Wednesday and Thursday",
               "$775","$800","$800","$800","$800","$775","$750"),ncol=3,byrow=F)

colnames(DOW) <- c("Shift", "Days_Off", "Wage")

as.table(DOW)
```

```
## 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
```

#Running the lp model

```
solve(ap)
```

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

By getting 0 as the value we get to know that there exists a model.

#Total Cost - Objective Function

```
get.objective(ap)
```

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

#the total wage expenses are optimized and there are enough number of workers for each day to work - “25,675” of the AP shipping service.

#how many workers are available each day to work (Variables)

```
get.variables(ap)
```

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

The variables are of from $x_1, x_2, x_3, x_4, x_5, x_6, x_7$ where, x_1 = Number of workers assigned to shift 1 are 2, x_2 = Number of workers assigned to shift 2 are 4, x_3 = Number of workers assigned to shift 3 are 5, x_4 = Number of workers assigned to shift 4 are 0, x_5 = Number of workers assigned to shift 5 are 8, x_6 = Number of workers assigned to shift 6 are 1, x_7 = Number of workers assigned to shift 7 are 13

By the variable values we got we can therefore get to see how many workers are available to work each day wrt. objective function and constraints.

Sunday = $x_2 + x_3 + x_4 + x_5 + x_6 = 18$ Workers Monday = $x_3 + x_4 + x_5 + x_6 + x_7 = 27$ Workers Tuesday = $x_4 + x_5 + x_6 + x_7 + x_1 = 24$ Workers Wednesday = $x_5 + x_6 + x_7 + x_1 + x_2 = 28$ Workers Thursday = $x_6 + x_7 + x_1 + x_2 + x_3 = 25$ Workers Friday = $x_7 + x_1 + x_2 + x_3 + x_4 = 24$ Workers Saturday = $x_1 + x_2 + x_3 + x_4 + x_5 = 19$ Workers