QMM #6

#Packages used

```
library(Benchmarking)

## Loading required package: lpSolveAPI

## Loading required package: ucminf

## Loading required package: quadprog

library(lpSolveAPI)
library(ucminf)
library(quadprog)
#install.packages("data.tree")
library(data.tree)
```

#Formulate and solve the binary integer programming (BIP) model for this problem using library lpsolve or equivalent in R.

```
library(lpSolveAPI)
x <- read.lp("QMM#6.lp")
x

## Model name:
##   a linear program with 12 decision variables and 9 constraints

solve(x)

## [1] 0

get.objective(x)

## [1] 17

get.variables(x)

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

#The longest critical path is node 1, node 2,  node 5, node 7, node 9.
```

##Determine the maximum return on the portfolio. What is the optimal number of shares to buy for each of the stocks? What is the corresponding dollar amount invested in each stock?

```
library(lpSolveAPI)
x <- read.lp("#6 qmm #2.lp")
x
```

```
## Model name:
##   a linear program with 16 decision variables and 12 constraints

solve(x)

## [1] 0

get.objective(x)

## [1] 477050

get.variables(x)

##  [1]  4000  4000  2000  2000  3000 12000 30000  4000     4     4     2
2
## [13]     3    12    30     4

#The maximum return on the portfolio is $477,050. The optimal number of
shares to buy for each stock is 4,000 in stock S1, 4,000 in stock S2, 2,000
in stock S3, 2,000 in stock H1, 3,000 in stock H2, 12,000 in stock H3, 30,000
in stock C1, and 4,000 in stock C2. The corresponding dollar amount invested
in each stock is in the table below.
```

Stock	Formula	$ Invested in each Stock
S1	4,000* $40 =	$160,000
S2	4,000* $50 =	$200,000
S3	2,000*$80=	$160,000
H1	2,000*$60=	$120,000
H2	3,000*$45=	$135,000
H3	12,000*$60=	$720,000
C1	30,000*$30=	$900,000
C2	4,000*$25=	$100,000

Compare the solution in which there is no integer restriction on the number of shares invested. By how much (in percentage terms) do the integer restrictions alter the value of the optimal objective function? By how much (in percentage terms) do they alter the optimal investment quantities?

```
library(lpSolveAPI)
x <- read.lp("assignment 6 pt2.lp")
x

## Model name:
##   a linear program with 16 decision variables and 12 constraints

solve(x)

## [1] 0

get.objective(x)
```

```
## [1] 473050

get.variables(x)

##  [1]  3000  4000  2000  2000  3000 12000 30000  4000     3     4     2
2
## [13]     3    12    30     4
```

#When there is no integer restriction on the number of shares invested the maximum return is less than the problem above. There is a $4,000 difference. The optimal number of shares to buy for each stock is 3,000 in stock S1, 4,000 in stock S2, 2,000 in stock S3, 2,000 in stock H1, 3,000 in stock H2, 12,000 in stock H3, 30,000 in stock C1, and 4,000 in stock C2. The corresponding dollar amount invested in each stock is in the table below.

Stock	Formula	$ Invested in each Stock
S1	3,000* $40 =	$120,000
S2	4,000* $50 =	$200,000
S3	2,000*$80=	$160,000
H1	2,000*$60=	$120,000
H2	3,000*$45=	$135,000
H3	12,000*$60=	$720,000
C1	30,000*$30=	$900,000
C2	4,000*$25=	$100,000

In terms of percentage, the integer restrictions alter the value of the optimal objective function by -.838%.

No Integer Restrictions	Integer Restrictions	Change	Percentage
477,050	473,050	4,000	(4,000/477,050) *100= **-.838 %**

When there is no integer restriction on number of shares, in terms of percentage, having no restriction alters the optimal investment quantities. It only alters stock S1 by -25%.

Stock	No Integer Restrictions	Integer Restriction	Change	Percentage Change
S1	4,000	3,000	1,000	**-25%**
S2	4,000	4,000	0	0%
S3	2,000	2,000	0	0%
H1	2,000	2,000	0	0%
H2	3,000	3,000	0	0%
H3	12,000	12,000	0	0%
C1	30,000	30,000	0	0%

C2	4,000	4,000	0	0%