DATA 609 HW6

Bin Lin

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Page 251: #2. Nutritional Requirements-A rancher has determined that the minimum weekly nutritional requirements for an average-sized horse include 40 lb of protein, 20 lb of carbohydrates, and 45 lb of roughage. These are obtained from the following sources in varying amounts at the prices indicated:

	Protein (lb)	Carbohydrates (lb)	Roughage (lb)	Cost
Hay (per bale)	0.5	2.0	5.0	$1.80
Oats (per sack)	1.0	4.0	2.0	3.50
Feeding blocks (per block)	2.0	0.5	1.0	0.40
High-protein concentrate (per sack)	6.0	1.0	2.5	1.00
Requirements per horse (per week)	40.0	20.0	45.0	

Figure 1

Formulate a mathematical model to determine how to meet the minimum nutritional requirements at minimum cost.

Goal 1: Minimize Cost :

$$1.8x_1 + 3.5x_2 + 0.4x_3 + 1x_4$$

Goal 2: Protein:

$$0.5x_1 + 1x_2 + 2.0x_3 + 6x_4 \geq 40$$

Goal 3: Carbohydrates:

$$2.0x_1 + 4.0x_2 + 0.5x_3 + 1.0x_4 \geq 20$$

Goal 4: Roughage:

$$5.0x_1 + 2.0x_2 + 1.0x_3 + 2.5x_4 \geq 45$$

Goal 5:

$$x_1, x_2, x_3, x_4 \quad \geq 0$$

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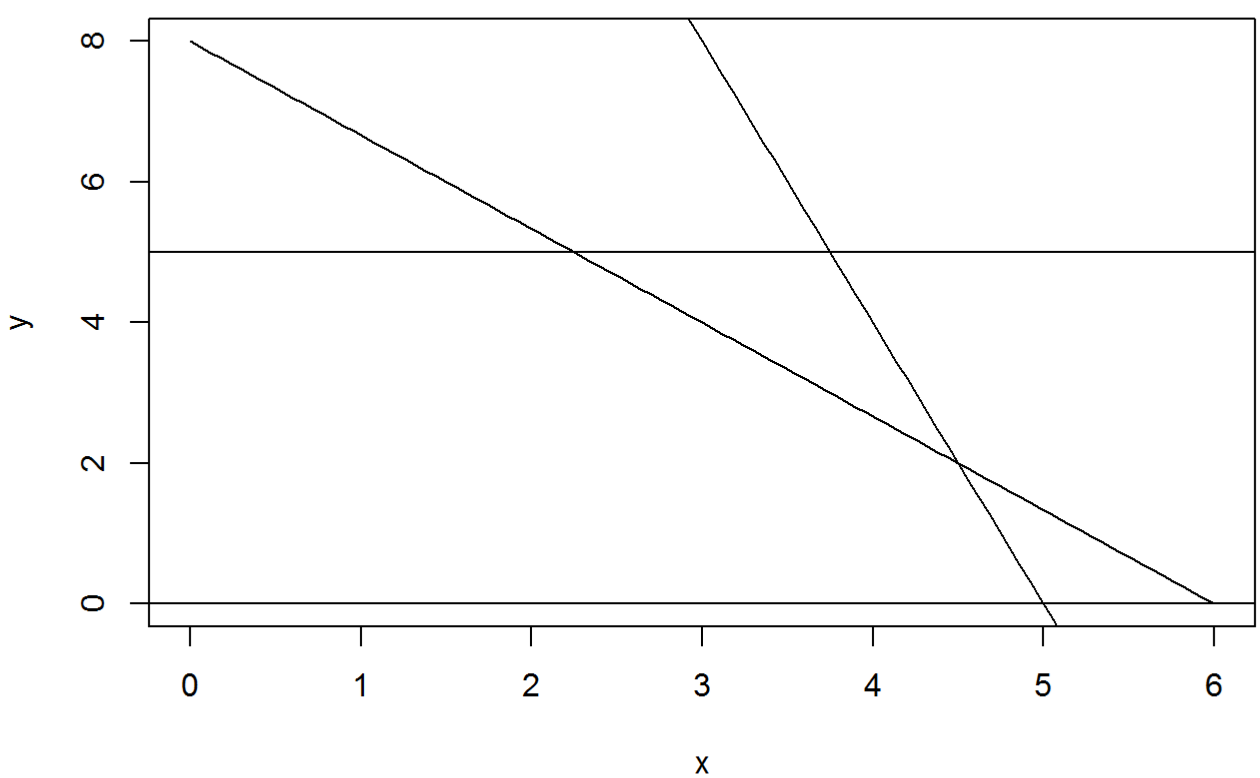
6. Maximize $10x + 35y$
subject to

$$
\begin{aligned}
8x + 6y &\le 48 \quad &\text{(board-feet of lumber)}\\
4x + y &\le 20 \quad &\text{(hours of carpentry)}\\
y &\ge 5 \quad &\text{(demand)}\\
x, y &\ge 0 \quad &\text{(nonnegativity)}
\end{aligned}
$$

Figure 2

```
lumber_boardfeet <- function(x){(48 - 8 * x) / 6}
carpentry_hours <- function(x){20 - 4 * x}


curve(lumber_boardfeet, from=0, to=6, xlab="x", ylab="y")
curve(carpentry_hours, from=0, to=6, xlab="x", ylab="y", add = TRUE)
abline(a = 5, b = 0)
abline(a = 0, b = 0)
```



According to the graph, the feasible region is nonempty and bounded convex triangle, which has three extreme points. They are (0, 5), (0, 8), (2.25, 5). The corresponding objective function are 175, 280, 197.5. Therefore, the objective function is maximized when x = 0, and y = 8.

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Use the Simplex Method to resolve Problems 6

```
#install.packages("lpSolve")
library("lpSolve")
```

```
## Warning: package 'lpSolve' was built under R version 3.3.2
```

```
f.obj <- c(10, 35)

row1 = c(8, 6)
row2 = c(4, 1)
row3 = c(0, 1)


f.con <- rbind(row1, row2, row3)
f.dir <- c("<=", "<=", ">=")
f.rhs <- c(48, 20, 5)

lp ("max", f.obj, f.con, f.dir, f.rhs)
```

```
## Success: the objective function is 280
```

```
lp ("max", f.obj, f.con, f.dir, f.rhs)$solution
```

```
## [1] 0 8
```

The result obtained from Simplex Method matches with that of graphicl analysis.