Learning outcomes

1. *Defining the Objective function and writing the constraints*
2. *Solving the Optimization problem using R , Excel and graphical methods*

1. A furniture maker has 6 units of wood and 28 hours of free time. Two models were sold well in the past. Model 1 requires 2 units of wood and 7 hours and model 2 requires 1 unit of wood and 8 hours of time. Selling Prices are Rs. 200 and 150 each. How many of each should he make to maximize the revenues?

   Step 1- Define the Decision Variables and construct the Objective Function.

   Let "M1" be the number of pieces of model 1, "M2" be the number of pieces of model 2. Let R be the revenue.
   The objective function can be defined as R = 200 * M1 +150 * M2; mathematically this function needs to be maximized.

   Step 2: Define the Constraints.

   1. $2 M1 + 1 M2 \leq 6$ (requires 2 pieces for model 1 & 1 piece for model 2; total 6
   2. $7M1 + 8M2 \leq 28$ – (requires 7 hrs for model 1 & 8 hrs for model2; total 28
   3. $M1 \geq 0$ and $M2 \geq 0$ - implicit constraints

   Step3: Writing the above in the form of matrix

```
f.obj = c(200, 150)
f.con = matrix (c(2, 1, 7, 8), nrow=2, byrow=TRUE)
f.dir = c("<=", "<=")
f.rhs = c(6,28)
```

   Step 4: Solve

```
# library(lpSolve)
```

   # Linear Programming

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

   # Integer Programming

```
lp ("max", f.obj, f.con, f.dir, f.rhs, int.vec=1:2)
lp ("max", f.obj, f.con, f.dir, f.rhs, int.vec=1:2)$solution
```

2. Solve using graphical method: A farmer has 240 acres to plant. He needs to decide how many acres of corn to plant and how many acres of oats. He can make $40 acre for corn and $30/acre for oats. However, corn takes 2 hours of labor/acre to harvest, and the oats take 1hr labor/acre. He has only 320 hours of labor he can invest. To maximize his profit, how many acres of each should he plant? (Try the same with Excel Solver and R).

   Solution provided in excel sheet

3. Transportation problem: Tropicsun currently has 275,000 bags of citrus at Mt. Dora, 400,000 bags at Eustis, and 300,000 bags at Clermont. Tropicsun has citrus processing plants in Ocala, Orlando, and Leesburg with processing capacities to handle 200,000, 600,000, and 225,000 bags, respectively.

   Tropicsun contracts with a local trucking company to transport its fruit from the groves to the processing plants. The trucking company charges a flat rate for every mile that each bushel of fruit must be transported. Each mile a bushel of fruit travels is known as a bushelmile. The following table summarizes the distances (in miles) between the groves and processing plants:

   Goal: Minimize cost - i.e. miles travelled between the groves and processing plants:

   Truck goes from Grove to Plant.9 variables (3 groves and 3 plants i.e. destination)

   Constraints:
   Ocala processing capacity: 200,000
   Orlando processing capacity: 600,000
   Leesburg processing capacity: 225,000

```
Obj <- c(21,50,40,35,30,22,55,20,25)
cost.mat <- matrix(obj,nrow=3,byrow=TRUE)
rowdir=c("=", "=", "=")
coldir=c("<=", "<=", "<=")
rowRhs=c(275000,400000,300000)
colRhs=c(200000, 600000, 225000)


trans <-  lp.transport (cost.mat, direction="min", rowdir, rowRhs, coldir,
                        colRhs, integers = 1:nrow(cost.mat)*ncol(cost.mat))

options(scipen=9)
trans$solution
```

4. The coach of a swim team needs to assign swimmers to a 200-yard medley relay team (four swimmers, each swims 50 yards of one of the four strokes). Since most of the best swimmers are very fast in more than one stroke, it is not clear which swimmer should be assigned to each of the four strokes. The five fastest swimmers and their best times (in seconds) they have achieved in each of the strokes (for 50 yards) are shown below.
Question: How should the swimmers be assigned to make the fastest relay team?

Best Times	**Backstroke**	**Breastroke**	**Butterfly**	**Freestyle**
Carl	37.7	43.4	33.3	29.2
Chris	32.9	33.1	28.5	26.4
David	33.8	42.2	38.9	29.6
Tony	37.0	34.7	30.4	28.5
Ken	35.4	41.8	33.6	31.1

```
f.obj <-  c(37.7,43.4,33.3,29.2,0,32.9,33.1,28.5,26.4,0,33.8,42.2,
          38.9,29.6,0,37,34.7,30.4,28.5,0,35.4,41.8,33.6,31.1,0)
costMtrx <- matrix(f.obj,nrow=5,byrow=TRUE)
a=lp.assign (costMtrx, direction="min")
a
a$solution
```