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**Citation: using R package IpsolveAPI to solve the lp part of my assignment in all problems.**

**Problem 1**

this problem is a typical Linear programming problem.

(a)

Variables

one ad variable X for each kind of ad of each outlet.

In this problem, X11-X15 is the number of menu ad for Dine, Gourment, Gastronomica, Taste of Home, Cooking Light. X21-X25, X31-X35 are number of celebrity and environment ad of them.

Constraints

1. the totoal costs of ads should be less or equal to the budget 5000
2. each ad of a oulet should be less or equal to the limits (15 constraints in total )

details of these constraints are represented in (b)

Objective Funtion

Max the total impact function, i.e.**,** the X (matrix of all kinds of ad) \* Transpose of Impact(impact of all kinds of ad)

max( X \* Impacts**T**) .

(b)

In this problem, we maximize c**T**x subject to Ax≤b and x≥0 where

C = (3,4,2,5,4,4,5,2,1,2,1,3,6,5,2)**T**

X = (x11, x12, x13, x14, x15, x21, x22, x23, x24, x25, x31, x32, x33, x34, x35)**T**

A =(

500, 400, 350, 100, 50, 1000, 1500, 500, 200, 80, 200, 400, 500, 100, 300,

1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0,

0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0,

0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0,

0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0,

0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1,

)

B = (5000,3,3,3,4,4)**T**

*Other limits constraints I made a bounder on X in R package IpsolveAPI.*

**After using lpsolve tool,**

**The optimal solution is p = 59.9**

**attained at X = (1.0 1.0 1.0 1.0 1.0 1.3 0.0 0.0 0.0 2.0 0.7 1.0 2.0 3.0 1.0)T**

Checking the constraints:

1. c**T**x = 5000<= 5000
2. c**T**x = 3 <= 3
3. c**T**x = 2 <= 3
4. c**T**x = 3 <= 3
5. c**T**x = 4 <= 4
6. c**T**x = 4 <= 4

**Problem 2**

In this problem, we maximize c**T**x subject to Ax≤b and x≥0 where

C = (0, 4.9, 0.7, 1.7, 0, 7.1)**T**

X = (x1, x2, x3, x4, x5, x6)**T**

A =(

3.6, 0.6, 5.9, 4.5, 0.4, 0.0,

0.0, 4.5, 0.0, 1.8, 0.0, 0.5,

8.1, 3.3, 0.0, 7.5, 0.0, 0.0,

5.8, 5.6, 0.0, 0.0, 0.0, 4.8,

1.5, 0.0, 0.9, 0.0, 1.8, 8.6,

3.1, 5.3, 0.0, 1.1, 8.0, 0.0,

0.0, 9.9, 0.0, 5.1, 0.0, 7.9,

0.0, 0.5, 5.3, 0.2, 8.6, 5.1

)

B = (7.4, 4.3, 0.9, 2, 2.6, 8.1, -3, -8.5)**T**

**After using lpsolve tool,**

**The optimal solution is p =3.16,**

**attained at X = (0.00, 0.21, 1.21, 0.03, 0.00, 0.18)T**

Checking the constraints:

1. c**T**x = 7.40 <= 7.4
2. c**T**x = 1.07 <= 4.3
3. c**T**x = 0.90 <=0.9
4. c**T**x = 2.00 <= 2
5. c**T**x = 2.60 <= 2.6
6. c**T**x = 1.13 <= 8.1
7. c**T**x = 3.58 >= -3
8. c**T**x = 7.42 >= -8.5

**Problem 3**

In this problem, we maximize c**T**x subject to Ax≤b and x≥0 where

Considering non-negative, replace p = x1 –x2, q = x3 –x4, r= x5 – x6,

s = x7 – x8.

C = (1, -1, 2, -2, 3, -3 , 4 ,-4)**T**

X = (x1, x2, x3, x4, x5, x6, x7, x8)**T**

A =(

2, 0, 4, 0,

0, 5, 3, 0,

8, 2, 0, 0,

1, 0, 0, 6,

0, 1, 7, 0,

0, 3, 0, 5

)

B = (-10, -12, 5, 2, 1, 8)**T**

**After using lpsolve tool,**

**The optimal solution is p =5.15**

**attained at X = (0.09 0.00 2.14 0.00 0.00 0.16 0.32 0.00)T**

Checking the constraints:

1. c**T**x = -0.47 >= -10
2. c**T**x = 10.19 >= -12
3. c**T**x = 5 <= 5
4. c**T**x = 2 <= 2
5. c**T**x = 1 <= 1
6. c**T**x = 8 <= 8

**Problem 4**

In this problem, we maximize c**T**x subject to Ax≤b and x≥0 where

C = (1.6, 1.7, 0.6, 9.3)**T**

X = (x1, x2, x3, x4)**T**

A =(

1.7, 4.7, -1.1, 2.7,

8.4, 5.9, -0.4, 0.0,

0.0, -1.4, 9.6, 7.0,

5.0, 0.3, 8.9,-1.5,

0.0,-1.1, 0.0, 8.1

)

B = (3.5, 5, 7.9, 9.9, 1.3)**T**

**After using lpsolve tool,**

**The optimal solution is p =4.28**

**attained at X = (0.12, 0.73, 0.74, 0.26)T**

Checking the constraints:

1. c**T**x = 3.5 <= 3.5
2. c**T**x = 5 <= 5
3. c**T**x = 7.90 <= 7.9
4. c**T**x = 7.02 <= 9.9
5. c**T**x = 1.30 <= 1.3

**Problem 5**

In this problem, we minimize c**T**x subject to Ax≤b and x≥0 where

C = (-5, 3, 5, -3, -4, -9)**T**

X = (a, b, c, d, e, f)**T**

A =(

-6, 3, 5, 2, 5, 6,

0, 10, 5, 5, -5, 8,

8, -4, 7, 4, -5, 3,

-4, -3, -5, -2, 9,-5,

3, 8, 4, -1, -4, 2

)

B = (1,4,10,-8,-4)**T**

**After using lpsolve tool,**

**The optimal solution is p = -54.35**

**attained at X = (5.85 0.71 0.00 0.00 6.80 0.00)T**

Checking the constraints:

1. c**T**x = 1 <= 1
2. c**T**x = -26.95 <= 4
3. c**T**x = 10 <= 10
4. c**T**x = 35.67 >= -8
5. c**T**x = -4 >= -4

dual problem

we minimize b**T**y subject to A**T**y≥c and y≥0

**The optimal solution is p = -54.35**

**attained at Y =(5.61 0 4.85 0 0.05)T**

Thus, the optimal solution of dual equals the original results.

So, original solution is optimal.