Modeling in R
and how it ?

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1 Linear and Integer Programming

Let the following data is given:
1. A certain firm can carry out projects of three types. 2. Staff consists of 4 employees, each of which is necessary for work on everyone of the projects.
Concrete data is set in next tables:

	Type of Project 1	Type of Project 2	Type of Project 3
Employees 1	2	4	5
Employees 2	1	8	6
Employees 3	7	4	5
Employees 4	4	6	8

This table describe how long employees work on each project.

	Profit from type of project
Project 1	1000$
Project 2	1400$
Project 3	1200$

This table describes how many there will be profits on sale of each project

	How many hours we have
Emploiees 1	120
Emploiees 2	280
Emploiees 3	240
Emploiees 4	360

How many working hours in our disposal

Problem -> Plan of Sale?

	Type of Project 1	Type of Project 2	Type of Project 3	
Employees 1	$2 * x_1$	$4 * x_2$	$5 * x_3$	$<= 120$
Employees 2	$1 * x_1$	$8 * x_2$	$6 * x_3$	$<= 280$
Employees 3	$7 * x_1$	$4 * x_2$	$5 * x_3$	$<= 240$
Employees 4	$4 * x_1$	$6 * x_2$	$8 * x_3$	$<= 360$

$F(x) = 1000 * x_1 + 1400 * x_2 + 1200 * x_3 -> max$
x_1, - count of project 1 type
x_2, - count of project 2 type
x_3, - count of project 3 type

$2 * x_1 + 4 * x_2 + 5 * x_3 <= 120$
$1 * x_1 + 8 * x_2 + 6 * x_3 <= 120$
$7 * x_1 + 4 * x_2 + 5 * x_3 <= 120$
$4 * x_1 + 6 * x_2 + 8 * x_3 <= 120$

```
> library("lpSolve")

> f.obj <- c(1000, 1400, 1200)

[1] 1000 1400 1200

> f.con <- matrix(c(2, 4, 5, 1, 8, 6, 7, 4, 5, 4, 6, 7), nrow = 4,
+     byrow = TRUE)

     [,1] [,2] [,3]
[1,]    2    4    5
[2,]    1    8    6
[3,]    7    4    5
[4,]    4    6    7

> f.dir <- c("<=", "<=", "<=", "<=")

[1] "<=" "<=" "<=" "<="

> f.rhs <- c(120, 280, 240, 360)

[1] 120 280 240 360

> lp_var <- lp("max", f.obj, f.con, f.dir, f.rhs)

Success: the objective function is 49200

> lp_var
```

```
Success: the objective function is 49200

> lp_var$solution

[1] 24 18  0
```

Project 1 —> 24 units
Project 2 —> 18 units
Project 3 —> 0 units
Our plan of sale is ready.

Now we have plan of sale and whats about addvertisment company. After investigation and research marketing we have next data:

Coverage of clients

TV	60 %
Radio	20 %
Press	10 %
Magazines	10 %

For TV our firm make two clips C1(old) and C2(new)

Clips	Like
C1	25 %
C2	35 %

$$Important : 25 + 35 == 60 \tag{1}$$

For Radio our firm make two clips R1(old) and R2(new)

Clips	Like
R1	12 %
R2	8 %

$$Important : 12 + 8 == 20 \tag{2}$$

For Press our firm make two articles PA1(old) and PA2(new)

Articles	Like
PA1	4 %
PA2	6 %

$$Important : 4 + 6 == 10 \tag{3}$$

For Journals our firm make two articles JA1(old) and JA2(new)

Articles	Д
JA1	4 %
JA2	6 %

$$Important : 4 + 6 == 10 \tag{4}$$

Was poll of experts on which basis is moved it is offered as expenses for the publication or a mention for each advertizing material should be distributed

if to use data of this poll we may receive next table

		C1	C2	PA1	PA2	JA1	JA2	R1	R2
20	Radio	5	5	5	5	5	5	35	35
10	Press	5	5	28	22	15	15	5	5
60	TV	25	25	5	5	5	5	15	15
10	Journals	15	15	5	5	25	25	5	5
		25	35	4	6	4	6	12	8

In this case the decision is trivial and corresponds to preferences of clients. We can check up it, having solved a corresponding transport problem

	C1	C2	PA1	PA2	JA1	JA2	R1	R2	
Radio	$5 * x_{11}$	$5 * x_{12}$	$5 * x_{13}$	$5 * x_{14}$	$5 * x_{15}$	$5 * x_{16}$	$35 * x_{17}$	$35 * x_{18}$	<=20
Press	$5 * x_{21}$	$5 * x_{22}$	$28 * x_{23}$	$22 * x_{24}$	$15 * x_{25}$	$15 * x_{26}$	$5 * x_{27}$	$5 * x_{28}$	<=10
TV	$25 * x_{31}$	$25 * x_{32}$	$5 * x_{33}$	$5 * x_{34}$	$25 * x_{35}$	$25 * x_{36}$	$5 * x_{37}$	$5 * x_{38}$	<=60
Journals	$15 * x_{41}$	$15 * x_{42}$	$5 * x_{43}$	$5 * x_{44}$	$25 * x_{45}$	$25 * x_{46}$	$5 * x_{47}$	$5 * x_{48}$	<=10
	<=25	<=35	<=4	<=6	<=4	<=6	<=12	<=8	

Now solve

```
> f.obj <- c(5, 5, 5, 5, 5, 5, 35, 35, 5, 5, 28, 22, 15, 15, 5,
+     5, 25, 25, 5, 5, 5, 5, 15, 15, 15, 15, 5, 5, 25, 25, 5, 5)

 [1]  5  5  5  5  5  5 35 35  5  5 28 22 15 15  5  5 25 25  5  5  5  5 15 15 15
[26] 15  5  5 25 25  5  5

> f.con <- matrix(c(1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0,
+     0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
+     0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0,
+     0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
+     0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0,
+     0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
+     0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1,
+     0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0,
+     0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
+     0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1,
+     0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
+     0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
+     0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
+     1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
+     0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
+     0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0,
+     0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0,
+     0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0,
+     0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0,
+     0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1,
+     0, 0, 0, 0, 0, 0, 0, 1), nrow = 12, byrow = TRUE)
```

```
      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11] [,12] [,13]
 [1,]    1    1    1    1    1    1    1    1    0     0     0     0     0
 [2,]    0    0    0    0    0    0    0    0    1     1     1     1     1
 [3,]    0    0    0    0    0    0    0    0    0     0     0     0     0
 [4,]    0    0    0    0    0    0    0    0    0     0     0     0     0
 [5,]    1    0    0    0    0    0    0    0    1     0     0     0     0
 [6,]    0    1    0    0    0    0    0    0    0     1     0     0     0
 [7,]    0    0    1    0    0    0    0    0    0     0     1     0     0
 [8,]    0    0    0    1    0    0    0    0    0     0     0     1     0
 [9,]    0    0    0    0    1    0    0    0    0     0     0     0     1
[10,]    0    0    0    0    0    1    0    0    0     0     0     0     0
[11,]    0    0    0    0    0    0    1    0    0     0     0     0     0
[12,]    0    0    0    0    0    0    0    1    0     0     0     0     0
      [,14] [,15] [,16] [,17] [,18] [,19] [,20] [,21] [,22] [,23] [,24] [,25]
 [1,]     0     0     0     0     0     0     0     0     0     0     0     0
 [2,]     1     1     1     0     0     0     0     0     0     0     0     0
 [3,]     0     0     0     1     1     1     1     1     1     1     1     0
 [4,]     0     0     0     0     0     0     0     0     0     0     0     1
 [5,]     0     0     0     1     0     0     0     0     0     0     0     1
 [6,]     0     0     0     0     1     0     0     0     0     0     0     0
 [7,]     0     0     0     0     0     1     0     0     0     0     0     0
 [8,]     0     0     0     0     0     0     1     0     0     0     0     0
 [9,]     0     0     0     0     0     0     0     1     0     0     0     0
[10,]     1     0     0     0     0     0     0     0     1     0     0     0
[11,]     0     1     0     0     0     0     0     0     0     1     0     0
[12,]     0     0     1     0     0     0     0     0     0     0     1     0
      [,26] [,27] [,28] [,29] [,30] [,31] [,32]
 [1,]     0     0     0     0     0     0     0
 [2,]     0     0     0     0     0     0     0
 [3,]     0     0     0     0     0     0     0
 [4,]     1     1     1     1     1     1     1
 [5,]     0     0     0     0     0     0     0
 [6,]     1     0     0     0     0     0     0
 [7,]     0     1     0     0     0     0     0
 [8,]     0     0     1     0     0     0     0
 [9,]     0     0     0     1     0     0     0
[10,]     0     0     0     0     1     0     0
[11,]     0     0     0     0     0     1     0
[12,]     0     0     0     0     0     0     1

> f.dir <- c("<=", "<=", "<=", "<=", "<=", "<=", "<=", "<=", "<=",
+     "<=", "<=", "<=")

 [1] "<=" "<=" "<=" "<=" "<=" "<=" "<=" "<=" "<=" "<=" "<=" "<="
```

```
> f.rhs <- c(20, 10, 60, 10, 25, 35, 4, 6, 4, 6, 12, 8)

 [1] 20 10 60 10 25 35  4  6  4  6 12  8

> des <- lp("max", f.obj, f.con, f.dir, f.rhs)

Success: the objective function is 2694

> mm <- matrix(des$solution, , nrow = 4, byrow = TRUE)

     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8]
[1,]    0    0    0    0    0    0   12    8
[2,]    0    0    4    6    0    0    0    0
[3,]   25   35    0    0    0    0    0    0
[4,]    0    0    0    0    4    6    0    0
```

And, it has been told above.

How to be, in that case when the vector of preference of clients about advertizing products doesn't coincide with preferences about delivery systems to its clients. For example we remove conditions 1,2,3,4 for each product. It can occur when resources are estimated together, but not in pairs. Therefore equality of the sum of all estimations 100 will be unique restriction. Then if

		C1	C2	PA1	PA2	JA1	JA2	R1	R2
20	Radio	5	5	5	5	5	5	35	35
10	Press	5	5	28	22	15	15	5	5
60	TV	25	25	5	5	5	5	15	15
10	Journals	15	15	5	5	25	25	5	5
		15	15	5	5	25	25	5	5

We need chande only vector f.rhs <- c(20, 10,60,10,15 , 15 , 5 , 5 , 25 , 25 , 5 , 5)

```
> f.rhs <- c(20, 10, 60, 10, 15, 15, 5, 5, 25, 25, 5, 5)

 [1] 20 10 60 10 15 15  5  5 25 25  5  5

> des <- lp("max", f.obj, f.con, f.dir, f.rhs)

Success: the objective function is 1800

> mm <- matrix(des$solution, , nrow = 4, byrow = TRUE)

     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8]
[1,]    0    0    0    0    0   10    5    5
[2,]    0    0    5    5    0    0    0    0
[3,]   15   15    0    0   15   15    0    0
[4,]    0    0    0    0   10    0    0    0
```

		C1	C2	PA1	PA2	JA1	JA2	R1	R2
20	Radio	5	5	5	5	5	5	35	35
10	Press	5	5	28	22	15	15	5	5
60	TV	25	25	5	5	5	5	15	15
10	Journals	15	15	5	5	25	25	5	5
		15	15	5	5	25	25	5	5

This decision gives the chance to make elections on a template:

Row 1 -Radio: It is necessary to use both radio clips and speek about JA2.

Row 2 -Press: It is necessary to publish both articles

Row 3 -TV In equal quantities to place both clips and also to offer a clip on the cdrom together with magazines

По строке 4 It is necessary to publish only the first article in magazine, and the second to discuss on radio.

Col 1 and 2 It is necessary to show both clips on television Col 3 и 4 Both articles it is necessary to publish

Now a conclusion on cells. In them the percent from a total sum of financing which can be spent for the publication of this resource in соотвествующем mass-media is specified. That is, it is specified approximate финасовый the plan for an example the planned The sum on the advertizing company is equal 10 000 $, Then financing volumes turn out the following:

		C1	C2	PA1	PA2	JA1	JA2	R1	R2	2000 $
20	Radio	0	0	0	0	0	1000$	500$	500$	1000 $
10	Press	0	0	500 $	500 $	0	0	0	0	1000 $
60	TV	1500 $	1500 $	0	0	1500 $	1500 $	0	0	6000 $
10	Journals	0	0	0	0	1000 $	0	0	0	1000 $
Итого		1500 $	1500 $	500 $	500 $	2500 $	2500 $	500 $	500 $	