Simplex Presentation - EE5327

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Question

- Consider the linear programming problem
  Maximize $3x + 9y$,
  Subject to
  $$\begin{aligned} &2y - x <= 2, \\ &3y - x >= 2, \\ &2x + 3y <= 10, \\ &x, y >= 0. \end{aligned}$$
  Then the maximum value of the objective function is

Solution using CVXPY

```
import cvxpy as cvx
from numpy import matrix, round, eye
import numpy
X = cvx.Variable()
Y = cvx.Variable()
constraints = [-X + 2 * Y <= 2,
               3 * Y - X >= 0,
               2 * X + 3 * Y <= 10,
                X >= 0,
               Y >= 0]
obj = cvx.Maximize(3*X+9*Y)
prob = cvx.Problem(obj,constraints)
prob.solve()
print("Status:", prob.status)
print("Optimal value", prob.value)
print("Optimal var", X.value, Y.value)
```

Solution using CVXPY

- Status: optimal
  Optimal value 24.00
  Optimal var 2.00 2.00

Solution using SIMPLEX Method(Tabular)

Step 1 : Introduce Slack variables μ_1, μ_2, μ_3.
Step 2 : Transform the given LPP
After transformation given problem turns into :
Maximize $3x + 9y + 0\mu_1 + 0\mu_2 + 0\mu_3$,
Subject to

$$2y - x + \mu_1 = 2,$$
$$x - 3y + \mu_2 = 2,$$
$$2x + 3y + \mu_3 = 10,$$
$$x, y, \mu_1, \mu_2, \mu_3 >= 0.$$

Step 3 : Construct the tabulae

Solution using SIMPLEX Method(Tabular)

c_i	3	9	0	0	0		
	x	$\rightarrow$**y**	μ_1	μ_2	μ_3	RHS	θ
$\rightarrow\mathbf{0}\mu_1$	-1	**2**	1	0	0	2	1
$0\mu_2$	1	-3	0	1	0	0	-
$0\mu_3$	2	3	0	0	1	10	5
$c_i - z_i$	3	9	0	0	0	$Z_{RHS} = 0$	

Swap the variables μ_1 and y
Here the pivot element is 2,
Make it 1 and other elements in its column 0 using elementary row transformations.

$$R_1 = R_1/2$$
$$R_2 = R_2 + 3R_1$$
$$R_3 = R_3 - 3R_1$$

Solution using SIMPLEX Method(Tabular)

c_i	3	9	0	0	0		
	$\rightarrow$**x**	y	μ_1	μ_2	μ_3	RHS	θ
$0\mu_1$	-1	**2**	1	0	0	2	1
$0\mu_2$	1	-3	0	1	0	0	-
$0\mu_3$	2	3	0	0	1	10	5
$c_i - z_i$	3	9	0	0	0	$Z_{RHS} = 0$	
9y	-1/2	1	1/2	0	0	1	-
$0\mu_2$	-1/2	0	3/2	1	0	3	-
$\rightarrow\mathbf{0}\mu_3$	**7/2**	0	-3/2	0	1	7	2
$c_i - z_i$	15/2	0	-9/2	0	0	$Z_{RHS} = 9$	

Swap the variables μ_3 and x
Here the pivot element is 7/2,
Make it 1 and other elements in its column 0 using elementary row transformations.

Solution using SIMPLEX Method(Tabular)

c_i	3	9	0	0	0		
	$\rightarrow \mathbf{x}$	y	μ_1	μ_2	μ_3	RHS	θ
$0\mu_1$	-1	**2**	1	0	0	2	1
$0\mu_2$	1	-3	0	1	0	0	-
$0\mu_3$	2	3	0	0	1	10	5
$c_i - z_i$	3	9	0	0	0	$Z_{RHS} = 0$	
9y	-1/2	1	1/2	0	0	1	-
$0\mu_2$	-1/2	0	3/2	1	0	3	-
$\rightarrow \mathbf{0}\mu_3$	**7/2**	0	-3/2	0	1	7	2
$c_i - z_i$	15/2	0	-9/2	0	0	$Z_{RHS} = 9$	
9y	0	1	2/7	0	1/7	**2**$\leftarrow$	
$0\mu_2$	0	0	9/7	1	1/7	4	
3x	1	0	-3/7	0	2/7	**2**$\leftarrow$	
$c_i - z_i$	0	0	-12/7	0	-15/7	$Z_{RHS} = 24$	

Solution

Since the values of $c_i - z_i$ are all non positive, we can end the iterations.
Thus, the optimal values are as follows

$x = 2$

$y = 2$

Objective Function = $3x+9y = 24$.