Steven Glasford
3-5-20
Linear programming Assignment 2

①

1) Minimize z

$z = -4X_1 - X_2$

s.t.

$3X_1 + 6X_2 <= 15$

$8X_1 + 2X_2 <= 12$

$X_1, X_2 >= 0$

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canonical form

$z = -4X_1 - X_2 - 0X_3 - 0X_4$

$z + 4X_1 + X_2 + 0X_3 + 0X_4 = 0$

$3X_1 + 6X_2 + X_3 = 15$

$8X_1 + 2X_2 + 0X_4 = 12$

1	4	1	0	0	0
0	3	6	1	0	15
0	8	2	0	1	12

$\frac{15}{3} = 5$

$\frac{12}{8} = 1.5$

1	4	1	0	0	0
0	3	6	1	0	15
0	8	2	0	1	12

1	4	1	0	0	0
0	1	2	$\frac{1}{3}$	0	3
0	8	2	0	1	12

1	4	1	0	0	0
0	3	6	1	0	15
0	1	$\frac{1}{4}$	0	$\frac{1}{8}$	$\frac{3}{2}$

1	0	0	0	$-\frac{1}{2}$	-6
0	0	$\frac{2}{4}$	1	$-\frac{3}{8}$	$\frac{21}{2}$
0	1	$\frac{1}{4}$	0	$\frac{1}{8}$	$\frac{3}{2}$

1	0	-2	$-\frac{4}{3}$	0	-12
0	1	2	$\frac{1}{3}$	0	3
0	0	-14	$-\frac{8}{3}$	1	-12

1	0	0	0	$-\frac{1}{2}$	-6
0	0	$\frac{21}{4}$	1	$-\frac{3}{8}$	$2\frac{1}{2}$
0	1	$\frac{1}{4}$	0	$\frac{1}{8}$	$3/2$

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Alternative answer pivot
want to obtain a number for x_2

1	0	0	0	$-\frac{1}{2}$	-6
0	0	1	$\frac{4}{21}$	$-\frac{1}{14}$	2
0	1	$\frac{1}{4}$	0	$\frac{1}{8}$	$\frac{3}{2}$

1	0	0	0	$-\frac{1}{2}$	-6
0	0	1	$\frac{4}{21}$	$-\frac{1}{14}$	2
0	1	0	$-\frac{1}{21}$	$\frac{1}{7}$	1

$X_1 = 1$ 、$X_2 = 2$ 、$Z_{min} = -6$

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Linear programming assignment 2

③ ~~minimize~~ maximize z

$z = X_1 + 2X_2 - X_3$

S.t.

$4X_2 + X_3 \leq 40$

$X_1 - X_2 \leq 20$

$2X_1 + 4X_2 + 3X_3 \leq 60$

$X_1, X_2, X_3 \geq 0$

$z = X_1 + 2X_2 - X_3 + 0X_4 + 0X_5 + 0X_6$

$z - X_1 - 2X_2 + X_3 - 0X_4 - 0X_5 - 0X_6 = 0$

$0X_1 + 4X_2 + 0X_3 + X_4 = 40$

$X_1 - X_2 + X_5 = 20$

$2X_1 + 4X_2 + 3X_3 + X_6 = 60$

$X_{1\ldots6} \geq 0$

	z	X_1	X_2	X_3	X_4	X_5	X_6	RHS
	1	-1	-2	+1	0	0	0	0
1/4	0	0	4	1	1	0	0	40
	0	1	-1	0	0	1	0	21
	0	2	4	3	0	0	1	60

$40/4 = 10$

$21/-1 = -21$

$60/4 = 15$

z →	1	-1	-2	1	0	0	0	0
	0	0	1	1/4	1/4	0	0	10
	0	1	-1	0	0	1	0	21
4 →	0	2	4	3	0	0	1	60

④

1	-1	0	$\frac{3}{2}$	$\frac{1}{2}$	0	0	20
0	0	1	$\frac{1}{4}$	$\frac{1}{4}$	0	0	10
0	1	0	$\frac{1}{4}$	$\frac{1}{4}$	1	0	31
0	2	0	2	-1	0	1	20

$\frac{1}{2}$

31/1 = 31
20/2 = 10

1	-1	0	$\frac{3}{2}$	$\frac{1}{2}$	0	0	20
0	0	1	$\frac{1}{4}$	$\frac{1}{4}$	0	0	10
0	1	0	$\frac{1}{4}$	$\frac{1}{4}$	1	0	31
0	1	0	1	$-\frac{1}{2}$	0	$\frac{1}{2}$	10

1 → 0, -1 → 0

1	0	0	$\frac{5}{2}$	0	0	0	30
0	0	1	$\frac{1}{4}$	$\frac{1}{4}$	0	0	10
0	0	0	$-\frac{3}{4}$	$\frac{3}{4}$	1	$-\frac{1}{2}$	21
0	1	0	1	$-\frac{1}{2}$	0	$\frac{1}{2}$	10

$X_1 = 10$、$X_2 = 10$、$X_3 = 0$、$Z_{min} = 30$

In [7]:
```
import pulp as p
```

In [8]:
```
# problem 1
Lp_prob1 = p.LpProblem('Problem', p.LpMinimize)

x1 = p.LpVariable('x1',lowBound = 0)
y1 = p.LpVariable('y1',lowBound = 0)

# Objective function
Lp_prob1 += -4*x1 - y1

# Constraints
Lp_prob1 += 3*x1 + 6*y1 <= 15
Lp_prob1 += 8*x1 + 2*y1 <= 12
Lp_prob1 += x1 >= 0
Lp_prob1 += y1 >= 0

print(Lp_prob1)
status = Lp_prob1.solve()
print(p.LpStatus[status])
print(p.value(x1), p.value(y1), p.value(Lp_prob1.objective))
```

```
Problem:
MINIMIZE
-4*x1 + -1*y1 + 0
SUBJECT TO
_C1: 3 x1 + 6 y1 <= 15

_C2: 8 x1 + 2 y1 <= 12

_C3: x1 >= 0

_C4: y1 >= 0

VARIABLES
x1 Continuous
y1 Continuous

Optimal
1.0 2.0 -6.0
```

In [9]:
```
# Problem 2
Lp_prob2 = p.LpProblem('Problem', p.LpMaximize)

x2 = p.LpVariable('x2',lowBound = 0)
y2 = p.LpVariable('y2',lowBound = 0)
z2 = p.LpVariable('z2',lowBound = 0)

# Objective function
Lp_prob2 += x2 + 2*y2 - z

# Constraints
Lp_prob2 += 4*y2 + z2 <= 40
Lp_prob2 += x2 - y2 <= 20
Lp_prob2 += 2*x2 + 4*y2 + 3*z2 <= 60
Lp_prob2 += x2 >= 0
Lp_prob2 += y2 >= 0
Lp_prob2 += z2 >= 0

# Produce the output
print(Lp_prob2)
status = Lp_prob2.solve()
print(p.LpStatus[status])
print(p.value(x2), p.value(y2), p.value(z2), p.value(Lp_prob2.objective))
```

```
Problem:
MAXIMIZE
1*x2 + 2*y2 + -1*z + 0
SUBJECT TO
_C1: 4 y2 + z2 <= 40

_C2: x2 - y2 <= 20

_C3: 2 x2 + 4 y2 + 3 z2 <= 60

_C4: x2 >= 0

_C5: y2 >= 0

_C6: z2 >= 0

VARIABLES
x2 Continuous
y2 Continuous
z Continuous
z2 Continuous

Optimal
23.333333 3.3333333 0.0 29.9999996
```

In [ ]: