Contents

Problem1 - Step1

```
n = 4;
A = eye(n);
f = ones(n,1);
b = [6
    8
    10
    12];
lb = zeros(n,1);
intcon = 1:n;
x = intlinprog(f,intcon,-A,-b,[],[],lb,[],[],optimoptions('intlinprog'));

y = linprog(-b,A',f,[],[],zeros(4,1),[],optimset('linprog'));

a = [52 29 27 21];
pi = intlinprog(-y',intcon,a,80,[],[],zeros(4,1),[],[],optimoptions('intlinprog'));

fprintf('X_tilde = [%i %i %i %i], obj value = %i\n',x,f'*x)
fprintf('Y_tilde = [%4.2f %4.2f %4.2f %4.2f], obj value = %4.2f\n',y,b'*y)
fprintf('pi_tilde = [%i %i %i %i], obj value = %4.2f\n\n',pi, y'*pi)
```

```
LP:                Optimal objective value is 36.000000.


Optimal solution found.

Intlinprog stopped at the root node because the objective value is within a gap
tolerance of the optimal value, options.AbsoluteGapTolerance = 0 (the default
value). The intcon variables are integer within tolerance,
options.IntegerTolerance = 1e-05 (the default value).


Optimal solution found.

LP:                Optimal objective value is -3.629630.

Cut Generation:    Applied 1 strong CG cut.
                   Lower bound is -3.000000.
                   Relative gap is 0.00%.


Optimal solution found.

Intlinprog stopped at the root node because the objective value is within a gap
```

```
tolerance of the optimal value, options.AbsoluteGapTolerance = 0 (the default
value). The intcon variables are integer within tolerance,
options.IntegerTolerance = 1e-05 (the default value).

X_tilde = [6 8 10 12], obj value = 36
Y_tilde = [1.00 1.00 1.00 1.00], obj value = 36.00
pi_tilde = [0 0 0 3], obj value = 3.00
```

Problem1 - Step2

```
n = 5;
A = [A pi];
f = ones(n,1);
b = [6
    8
    10
    12];
lb = zeros(n,1);
intcon = 1:n;
x = intlinprog(f,intcon,-A,-b,[],[],lb,[],[],optimoptions('intlinprog'));

y = linprog(-b,A',f,[],[],zeros(4,1),[],optimset('linprog'));

a = [52 29 27 21];
pi = intlinprog(-y',1:4,a,80,[],[],zeros(4, 1),[],[],optimoptions('intlinprog'));

fprintf('X_tilde = [%i %i %i %i], obj value = %i\n',x,f'*x)
fprintf('Y_tilde = [%4.2f %4.2f %4.2f %4.2f], obj value = %4.2f\n',y,b'*y)
fprintf('pi_tilde = [%i %i %i %i], obj value = %4.2f\n\n',pi, y'*pi)
```

```
LP:                Optimal objective value is 28.000000.


Optimal solution found.

Intlinprog stopped at the root node because the objective value is within a gap
tolerance of the optimal value, options.AbsoluteGapTolerance = 0 (the default
value). The intcon variables are integer within tolerance,
options.IntegerTolerance = 1e-05 (the default value).


Optimal solution found.

LP:                Optimal objective value is -2.896552.

Cut Generation:    Applied 2 Gomory cuts.
                   Lower bound is -2.333333.
                   Relative gap is 0.00%.


Optimal solution found.

Intlinprog stopped at the root node because the objective value is within a gap
tolerance of the optimal value, options.AbsoluteGapTolerance = 0 (the default
value). The intcon variables are integer within tolerance,
```

```
options.IntegerTolerance = 1e-05 (the default value).

X_tilde = [6 8 10 0 4], obj value = 28
Y_tilde = [1.00 1.00 1.00 0.33], obj value = 28.00
pi_tilde = [0 0 2 1], obj value = 2.33
```

Problem1 - Step3

```
n = 6;
A = [A pi];
f = ones(n,1);
b = [6
    8
    10
    12];
lb = zeros(n,1);
intcon = 1:n;
x = intlinprog(f,intcon,-A,-b,[],[],lb,[],[],optimoptions('intlinprog'));

y = linprog(-b,A',f,[],[],zeros(4,1),[],optimset('linprog'));

a = [52 29 27 21];
pi = intlinprog(-y',1:4,a,80,[],[],zeros(4, 1),[],[],optimoptions('intlinprog'));

fprintf('X_tilde = [%i %i %i %i %i], obj value = %i\n',x,f'*x)
fprintf('Y_tilde = [%4.2f %4.2f %4.2f %4.2f], obj value = %4.2f\n',y,b'*y)
fprintf('pi_tilde = [%i %i %i %i], obj value = %4.2f\n\n',pi, y'*pi)
```

```
LP:                Optimal objective value is 21.333333.

Cut Generation:    Applied 1 Gomory cut.
                   Lower bound is 22.000000.
                   Relative gap is 0.00%.


Optimal solution found.

Intlinprog stopped at the root node because the objective value is within a gap
tolerance of the optimal value, options.AbsoluteGapTolerance = 0 (the default
value). The intcon variables are integer within tolerance,
options.IntegerTolerance = 1e-05 (the default value).


Optimal solution found.

LP:                Optimal objective value is -2.423077.

Cut Generation:    Applied 1 implication cut, and 1 mir cut.
                   Lower bound is -2.333333.
                   Relative gap is 0.00%.


Optimal solution found.

Intlinprog stopped at the root node because the objective value is within a gap
```

```
tolerance of the optimal value, options.AbsoluteGapTolerance = 0 (the default
value). The intcon variables are integer within tolerance,
options.IntegerTolerance = 1e-05 (the default value).

X_tilde = [6 8 0 0 2.000000e+00 6.000000e+00], obj value = 22
Y_tilde = [1.00 1.00 0.33 0.33], obj value = 21.33
pi_tilde = [0 2 0 1.000000e+00], obj value = 2.33
```

Problem1 - Step4

```
n = 7;
A = [A pi];
f = ones(n,1);
b = [6
    8
    10
    12];
lb = zeros(n,1);
intcon = 1:n;
x = intlinprog(f,intcon,-A,-b,[],[],lb,[],[],optimoptions('intlinprog'));

y = linprog(-b,A',f,[],[],zeros(4,1),[],optimset('linprog'));

a = [52 29 27 21];
pi = intlinprog(-y',1:4,a,80,[],[],zeros(4, 1),[],[],optimoptions('intlinprog'));

fprintf('X_tilde = [%i %i %i %i %i %i], obj value = %i\n',x,f'*x)
fprintf('Y_tilde = [%4.2f %4.2f %4.2f %4.2f], obj value = %4.2f\n',y,b'*y)
fprintf('pi_tilde = [%i %i %i %i], obj value = %4.2f\n\n',pi, y'*pi)
```

```
LP:                Optimal objective value is 16.000000.


Optimal solution found.

Intlinprog stopped at the root node because the objective value is within a gap
tolerance of the optimal value, options.AbsoluteGapTolerance = 0 (the default
value). The intcon variables are integer within tolerance,
options.IntegerTolerance = 1e-05 (the default value).


Optimal solution found.

LP:                Optimal objective value is -1.444444.

Cut Generation:    Applied 1 mir cut.
                   Lower bound is -1.333333.
                   Relative gap is 0.00%.


Optimal solution found.

Intlinprog stopped at the root node because the objective value is within a gap
tolerance of the optimal value, options.AbsoluteGapTolerance = 0 (the default
value). The intcon variables are integer within tolerance,
```

```
options.IntegerTolerance = 1e-05 (the default value).

X_tilde = [6 0 0 0 1.000000e+00 5.000000e+00], obj value = 4
X_tilde = [16 Y_tilde = [1.00 0.33 0.33 0.33], obj value = 16.00
pi_tilde = [1 0 0 1], obj value = 1.33
```

Problem1 - Step5

```
n = 8;
A = [A pi];
f = ones(n,1);
b = [6
    8
    10
    12];
lb = zeros(n,1);
intcon = 1:n;
x = intlinprog(f,intcon,-A,-b,[],[],lb,[],[],optimoptions('intlinprog'));

y = linprog(-b,A',f,[],[],zeros(4,1),[],optimset('linprog'));

a = [52 29 27 21];
pi = intlinprog(-y',1:4,a,80,[],[],zeros(4, 1),[],[],optimoptions('intlinprog'));

fprintf('X_tilde = [%i %i %i %i %i %i], obj value = %i\n',x,f'*x)
fprintf('Y_tilde = [%4.2f %4.2f %4.2f %4.2f], obj value = %4.2f\n',y,b'*y)
fprintf('pi_tilde = [%i %i %i %i], obj value = %4.2f\n\n',pi, y'*pi)
```

```
LP:                Optimal objective value is 15.000000.


Optimal solution found.

Intlinprog stopped at the root node because the objective value is within a gap
tolerance of the optimal value, options.AbsoluteGapTolerance = 0 (the default
value). The intcon variables are integer within tolerance,
options.IntegerTolerance = 1e-05 (the default value).


Optimal solution found.

LP:                Optimal objective value is -1.518519.

Cut Generation:    Applied 1 mir cut.
                   Lower bound is -1.500000.
                   Relative gap is 0.00%.


Optimal solution found.

Intlinprog stopped at the root node because the objective value is within a gap
tolerance of the optimal value, options.AbsoluteGapTolerance = 0 (the default
value). The intcon variables are integer within tolerance,
options.IntegerTolerance = 1e-05 (the default value).
```

```
X_tilde = [3.000000e+00 0 0 0 0 5], obj value = 4
X_tilde = [3.000000e+00 1.500000e+01 Y_tilde = [1.00 0.50 0.50 0.00], obj value = 15.00
pi_tilde = [1 0 1.000000e+00 0], obj value = 1.50
```

Problem1 - Step6

```
n = 9;
A = [A pi];
f = ones(n,1);
b = [6
    8
    10
    12];
lb = zeros(n,1);
intcon = 1:n;
x = intlinprog(f,intcon,-A,-b,[],[],lb,[],[],optimoptions('intlinprog'));

y = linprog(-b,A',f,[],[],zeros(4,1),[],optimset('linprog'));

a = [52 29 27 21];
pi = intlinprog(-y',1:4,a,80,[],[],zeros(4, 1),[],[],optimoptions('intlinprog'));

fprintf('X_tilde = [%i %i %i %i %i %i], obj value = %i\n',x,f'*x)
fprintf('Y_tilde = [%4.2f %4.2f %4.2f %4.2f], obj value = %4.2f\n',y,b'*y)
fprintf('pi_tilde = [%i %i %i %i], obj value = %4.2f\n\n',pi, y'*pi)
```

```
LP:                Optimal objective value is 14.000000.


Optimal solution found.

Intlinprog stopped at the root node because the objective value is within a gap
tolerance of the optimal value, options.AbsoluteGapTolerance = 0 (the default
value). The intcon variables are integer within tolerance,
options.IntegerTolerance = 1e-05 (the default value).


Optimal solution found.

LP:                Optimal objective value is -1.217949.

Cut Generation:    Applied 1 flow cover cut,
                   and 2 Gomory cuts.
                   Lower bound is -1.145299.

Heuristics:        Found 1 solution using rounding.
                   Upper bound is -1.000000.
                   Relative gap is 7.26%.

Branch and Bound:

   nodes     total   num int        integer       relative
explored  time (s)  solution           fval        gap (%)
       3      0.01         2  -1.000000e+00   7.037037e+00
      15      0.01         2  -1.000000e+00   0.000000e+00
```

```
Optimal solution found.

Intlinprog stopped because the objective value is within a gap tolerance of the
optimal value, options.AbsoluteGapTolerance = 0 (the default value). The intcon
variables are integer within tolerance, options.IntegerTolerance = 1e-05 (the
default value).

X_tilde = [0 0 0 0 2.000000e+00 2.000000e+00], obj value = 4
X_tilde = [0 6 14 Y_tilde = [0.67 0.33 0.33 0.33], obj value = 14.00
pi_tilde = [0 0 2 1], obj value = 1.00
```

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