Mukul Shingwani

B20AI023

Lab10

```
pip install GEKKO
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simpl
Requirement already satisfied: GEKKO in /usr/local/lib/python3.7/dist-packages (1.0.5)
Requirement already satisfied: numpy>=1.8 in /usr/local/lib/python3.7/dist-packages (from GEKKO)
```

```
from gekko import GEKKO
from numpy import *
```

Question 1

```
m = GEKKO(remote=False)
c = array([[9],[5],[6],[4]])
A = array([[6,3,5,2],[1,0,0,1],[-1,0,1,0],[0,-1,0,1]])
b = array([[10],[1],[0],[0]])
z = m.Array(m.Var,4,integer=True,lb=0,ub=1)
m.qobj(c,x=z,otype='max')
m.axb(A,b,x=z,etype='<=')
m.options.SOLVER = 1
m.solve()
print('Objective: ', m.options.OBJFCNVAL)
print(z)
```

```
A
[[ 6.  3.  5.  2.]
 [ 1.  0.  0.  1.]
 [-1.  0.  1.  0.]
 [ 0. -1.  0.  1.]]
b
[[10.  1.  0.  0.]]
 ----------------------------------------------------------------
 APMonitor, Version 1.0.1
 APMonitor Optimization Suite
 ----------------------------------------------------------------


 --------- APM Model Size ------------
```

```
 Each time step contains
   Objects      :            2
   Constants    :            0
   Variables    :            4
   Intermediates:            0
   Connections  :            8
   Equations    :            0
   Residuals    :            0

 Number of state variables:              4
 Number of total equations: -            4
 Number of slack variables: -            0
 ----------------------------------------
 Degrees of freedom       :              0

 ----------------------------------------------
 Steady State Optimization with APOPT Solver
 ----------------------------------------------
Iter:     1 I:  0 Tm:      0.00 NLPi:    1 Dpth:    0 Lvs:    3 Obj: -1.52E+01 Gap:       NaN
--Integer Solution:  -1.40E+01 Lowest Leaf:  -1.52E+01 Gap:   7.90E-02
Iter:     2 I:  0 Tm:      0.00 NLPi:    1 Dpth:    1 Lvs:    2 Obj: -1.40E+01 Gap:  7.90E-02
Iter:     3 I: -1 Tm:      0.00 NLPi:    3 Dpth:    1 Lvs:    1 Obj: -1.52E+01 Gap:  7.90E-02
--Integer Solution:  -1.40E+01 Lowest Leaf:  -1.40E+01 Gap:   0.00E+00
Iter:     4 I:  0 Tm:      0.00 NLPi:    1 Dpth:    1 Lvs:    1 Obj: -1.40E+01 Gap:  0.00E+00
 Successful solution

 ---------------------------------------------------
 Solver         :  APOPT (v1.0)
 Solution time  :   1.200000000062573E-002 sec
 Objective      :   -14.0000000000000
 Successful solution
 ---------------------------------------------------


Objective:  -14.0
[[1.0] [1.0] [0.0] [0.0]]
```

Question 2

```
m = GEKKO(remote=False)
c = array([[7.0],[3.0]])
A = array([[5,7],[4,1],[3,-2],[-1,0],[0,-1]])
b = array([[27],[14],[9],[0],[0]])
z1=m.Var(1,integer=True)
z2=m.Var(1,integer=False)
z=[z1,z2]
print(z1,z2,z)
m.qobj(c,x=z,otype='max')
m.axb(A,b,x=z,etype='<=')

m.options.SOLVER = 1
```

```
m.solve()
print('Objective: ', m.options.OBJFCNVAL)
print(z)
```

```
int_v1 v2 [1, 1]
A
[[ 5.  7.]
 [ 4.  1.]
 [ 3. -2.]
 [-1.  0.]
 [ 0. -1.]]
b
[[27. 14.  9.  0.  0.]]
 ----------------------------------------------------------------
 APMonitor, Version 1.0.1
 APMonitor Optimization Suite
 ----------------------------------------------------------------


 --------- APM Model Size ------------
 Each time step contains
   Objects      :            2
   Constants    :            0
   Variables    :            2
   Intermediates:            0
   Connections  :            4
   Equations    :            0
   Residuals    :            0

 Number of state variables:              2
 Number of total equations: -            5
 Number of slack variables: -            0
 ----------------------------------------
 Degrees of freedom       :             -3

 * Warning: DOF <= 0
 ----------------------------------------------
 Steady State Optimization with APOPT Solver
 ----------------------------------------------
Iter:     1 I:  0 Tm:      0.00 NLPi:    2 Dpth:    0 Lvs:    2 Obj: -2.66E+01 Gap:       NaN
Iter:     2 I: -1 Tm:      0.00 NLPi:    3 Dpth:    1 Lvs:    1 Obj: -2.66E+01 Gap:       NaN
--Integer Solution:  -2.61E+01 Lowest Leaf:  -2.61E+01 Gap:   0.00E+00
Iter:     3 I:  0 Tm:      0.00 NLPi:    3 Dpth:    1 Lvs:    1 Obj: -2.61E+01 Gap:  0.00E+00
 Successful solution

 ---------------------------------------------------
 Solver         :  APOPT (v1.0)
 Solution time  :   1.239999999961583E-002 sec
 Objective      :   -26.1428571428571
 Successful solution
 ---------------------------------------------------


Objective:  -26.142857143
[[3.0], [1.7142857143]]
```

Question 3

```
m = GEKKO(remote=False)
c = array([[1.0],[1.0]])
A = array([[3,-2],[-8,10]])
b = array([[-1],[10]])
z1=m.Var(1,integer=False,lb=0.3)
z2=m.Var(1,integer=True,lb=0,ub=1)
z=[z1,z2]
print(z1,z2,z)
m.qobj(c,x=z,otype='min')
m.axb(A,b,x=z,etype='<=')

m.options.SOLVER = 1
m.solve()
print('Objective: ', m.options.OBJFCNVAL)
print(z)
```

```
v1 int_v2 [1, 1]
A
[[ 3. -2.]
 [-8. 10.]]
b
[[-1. 10.]]
 ----------------------------------------------------------------
 APMonitor, Version 1.0.1
 APMonitor Optimization Suite
 ----------------------------------------------------------------


 --------- APM Model Size ------------
 Each time step contains
   Objects      :            2
   Constants    :            0
   Variables    :            2
   Intermediates:            0
   Connections  :            4
   Equations    :            0
   Residuals    :            0

 Number of state variables:              2
 Number of total equations: -            2
 Number of slack variables: -            0
 ----------------------------------------
 Degrees of freedom       :              0

 ----------------------------------------------
 Steady State Optimization with APOPT Solver
 ----------------------------------------------
```

```
Iter:     1 I:  0 Tm:      0.00 NLPi:    2 Dpth:    0 Lvs:    2 Obj:  1.25E+00 Gap:       NaN
--Integer Solution:   1.30E+00 Lowest Leaf:   1.25E+00 Gap:   3.92E-02
Iter:     2 I:  0 Tm:      0.00 NLPi:    1 Dpth:    1 Lvs:    1 Obj:  1.30E+00 Gap:  3.92E-02
Iter:     3 I: -1 Tm:      0.00 NLPi:    0 Dpth:    1 Lvs:    0 Obj:  1.25E+00 Gap:  3.92E-02
 No additional trial points, returning the best integer solution
 Successful solution

 ---------------------------------------------------
 Solver         :  APOPT (v1.0)
 Solution time  :   1.159999999981665E-002 sec
 Objective      :    1.30000000000000
 Successful solution
 ---------------------------------------------------


Objective:  1.3
[[0.3], [1.0]]
```

Question 4

```
m = GEKKO(remote=False)
c = array([[120],[85],[105],[140],[70]])
A = array([[55,45,60,50,30],[40,35,25,35,30],[25,20,0,30,0],[0,0,1,1,0]])
b = array([[150],[110],[60],[1]])
z = m.Array(m.Var,5,integer=True,lb=0,ub=1)
m.qobj(c,x=z,otype='max')
m.axb(A,b,x=z,etype='<=')
m.options.SOLVER = 1
m.solve()
print('Objective: ', m.options.OBJFCNVAL)
print(z)
```

```
A
[[55. 45. 60. 50. 30.]
 [40. 35. 25. 35. 30.]
 [25. 20.  0. 30.  0.]
 [ 0.  0.  1.  1.  0.]]
b
[[150. 110.  60.   1.]]
 ------------------------------------------------------------------
 APMonitor, Version 1.0.1
 APMonitor Optimization Suite
 ------------------------------------------------------------------


 --------- APM Model Size ------------
 Each time step contains
   Objects      :            2
   Constants    :            0
   Variables    :            5
   Intermediates:            0
```

```
      Connections  :           10
      Equations    :            0
      Residuals    :            0

     Number of state variables:              5
     Number of total equations: -            4
     Number of slack variables: -            0
     ----------------------------------------
     Degrees of freedom       :              1

     ---------------------------------------------
     Steady State Optimization with APOPT Solver
     ---------------------------------------------
    Iter:     1 I:  0 Tm:      0.00 NLPi:    2 Dpth:    0 Lvs:    3 Obj: -3.42E+02 Gap:       NaN
    --Integer Solution:  -3.30E+02 Lowest Leaf:  -3.42E+02 Gap:   3.72E-02
    Iter:     2 I:  0 Tm:      0.00 NLPi:    1 Dpth:    1 Lvs:    2 Obj: -3.30E+02 Gap:  3.72E-02
    Iter:     3 I:  0 Tm:      0.00 NLPi:    2 Dpth:    1 Lvs:    4 Obj: -3.34E+02 Gap:  3.72E-02
    --Integer Solution:  -3.30E+02 Lowest Leaf:  -3.34E+02 Gap:   1.15E-02
    Iter:     4 I:  0 Tm:      0.00 NLPi:    2 Dpth:    1 Lvs:    3 Obj: -3.30E+02 Gap:  1.15E-02
    Iter:     5 I:  0 Tm:      0.00 NLPi:    2 Dpth:    2 Lvs:    2 Obj: -2.81E+02 Gap:  1.15E-02
    Iter:     6 I:  0 Tm:      0.00 NLPi:    2 Dpth:    2 Lvs:    1 Obj: -3.25E+02 Gap:  1.15E-02
    Iter:     7 I:  0 Tm:      0.00 NLPi:    3 Dpth:    2 Lvs:    0 Obj: -3.20E+02 Gap:  1.15E-02
     No additional trial points, returning the best integer solution
     Successful solution

     ---------------------------------------------------
     Solver         :  APOPT (v1.0)
     Solution time  :   1.209999999991851E-002 sec
     Objective      :   -330.000000000000
     Successful solution
     ---------------------------------------------------


    Objective:  -330.0
    [[1.0] [0.0] [0.0] [1.0] [1.0]]

            ---------------------------------------------------------------------- END -----------------------------------------------------------------------
```

Colab paid products - Cancel contracts here

✓ 0s completed at 6:24 PM