```
"E:\1 □□□□\3 □□□□□\1 □□□□□□\1 □□□□□□□□\1_□□□□□□_□□□□\1_LW _□□□□\4 □□□□\3 python_code\1 exzample\2 □□□□□□\9 Code for this paper\Scripts\python.exe" "D:\Python\Pycharm\setroute\PyCharm Community Edition 2021.2.3\plugins\python-ce\helpers\pydev\pydevconsole.py" --mode=client --port=51079

import sys; print('Python %s on %s' % (sys.version, sys.platform))
sys.path.extend(['E:\\1 □□□□\\3 □□□□□\\1 □□□□□□\\1 □□□□□□□□\\1_□□□□□□_□□□□\\1_LW _□□□□\\4 □□□□\\3 python_code\\9 Code for this paper', 'E:/1 □□□□/3 □□□□□/1 □□□□□□/1 □□□□□□□□/1_□□□□□□_□□□□/1_LW _□□□□/4 □□□□/3 python_code/9 Code for this paper'])

PyDev console: starting.

Python 3.9.7 (tags/v3.9.7:1016ef3, Aug 30 2021, 20:19:38) [MSC v.1929 64 bit (AMD64)] on win32
>>> runfile('E:/1 □□□□/3 □□□□□/1 □□□□□□/1 □□□□□□□□/1_□□□□□□_□□□□/1_LW _□□□□/4 □□□□/3 python_code/9 Code for this paper/main_RO_BDC.py', wdir='E:/1 □□□□/3 □□□□□/1 □□□□□□/1 □□□□□□□□/1_□□□□□□_□□□□/1_LW _□□□□/4 □□□□/3 python_code/9 Code for this paper')
Backend TkAgg is interactive backend. Turning interactive mode on.
Waiting 5s.....
Set parameter MIPGap to value 1e-10
Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)

CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
Thread count: 4 physical cores, 8 logical processors, using up to 8 threads

Optimize a model with 546361 rows, 52642 columns and 1529305 nonzeros
Model fingerprint: 0x080f55c9
Variable types: 1 continuous, 52641 integer (52605 binary)
Coefficient statistics:
  Matrix range     [1e+00, 1e+10]
  Objective range  [1e+00, 2e+01]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 2e+10]
Warning: Model contains large matrix coefficients
Warning: Model contains large rhs
         Consider reformulating model or setting NumericFocus parameter
         to avoid numerical issues.
Presolve removed 323914 rows and 24616 columns (presolve time = 5s) ...
Presolve removed 462566 rows and 35488 columns
Presolve time: 9.58s
Presolved: 83795 rows, 17154 columns, 258615 nonzeros
Variable types: 0 continuous, 17154 integer (17127 binary)

Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
Showing first log only...

Root relaxation presolved: 17154 rows, 100949 columns, 275769 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    7.8000000e+02   0.000000e+00   1.001000e+03     10s
Concurrent spin time: 0.01s

Solved with dual simplex (primal model)

Root relaxation: objective 7.800000e+02, 2393 iterations, 0.47 seconds (0.38 work units)

    Nodes    |    Current Node    |     Objective Bounds      |     Work
 Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time

     0     0  780.00000    0   14          -  780.00000      -     -   10s
     0     0  780.00000    0   38          -  780.00000      -     -   11s
H    0     0                1740.0000000  780.00000  55.2%     -   11s
     0     0  780.00000    0    6 1740.00000  780.00000  55.2%     -   13s
     0     0  780.00000    0   36 1740.00000  780.00000  55.2%     -   14s
     0     0  780.00000    0   33 1740.00000  780.00000  55.2%     -   14s
     0     0  780.00000    0   51 1740.00000  780.00000  55.2%     -   15s
     0     0  780.00000    0   88 1740.00000  780.00000  55.2%     -   15s
     0     0  780.00000    0   86 1740.00000  780.00000  55.2%     -   15s
H    0     0                780.0000000  780.00000  0.00%     -   16s
     0     0  780.00000    0    2  780.00000  780.00000  0.00%     -   16s

Cutting planes:
  Cover: 113
  Implied bound: 1178
  Clique: 21
  MIR: 117
  StrongCG: 84
  GUB cover: 6
  Zero half: 7
  Mod-K: 15
  RLT: 18
  Relax-and-lift: 16
  BQP: 3

```

```
Explored 1 nodes (24632 simplex iterations) in 16.69 seconds (27.90 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 780 1740

Optimal solution found (tolerance 1.00e-10)
Best objective 7.800000000000e+02, best bound 7.800000000000e+02, gap 0.0000%
Set parameter MIPGap to value 1e-08
Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)

CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
Thread count: 4 physical cores, 8 logical processors, using up to 8 threads

Optimize a model with 2481733 rows, 1955335 columns and 17236336 nonzeros
Model fingerprint: 0x37c8cb7f
Variable types: 963295 continuous, 992040 integer (985965 binary)
Coefficient statistics:
  Matrix range     [1e-01, 1e+10]
  Objective range  [6e-05, 5e+01]
  Bounds range     [1e+00, 8e+01]
  RHS range        [8e-01, 1e+10]
Warning: Model contains large matrix coefficients
Warning: Model contains large rhs
         Consider reformulating model or setting NumericFocus parameter
         to avoid numerical issues.
Presolve removed 2478607 rows and 1954205 columns (presolve time = 5s) ...
Presolve removed 2478702 rows and 1954207 columns
Presolve time: 5.87s
Presolved: 3031 rows, 1128 columns, 8112 nonzeros
Variable types: 6 continuous, 1122 integer (664 binary)
Found heuristic solution: objective 3035.0500186
Found heuristic solution: objective 3411.0500186

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    8.9062796e+03   4.419845e+03   0.000000e+00      7s
     900    4.8910500e+03   0.000000e+00   0.000000e+00      7s

Root relaxation: objective 4.891050e+03, 900 iterations, 0.01 seconds (0.01 work units)

    Nodes    |    Current Node    |     Objective Bounds      |     Work
 Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time

     0     0 4891.05002    0   24 3411.05002 4891.05002  43.4%     -    7s
H    0     0                4825.0500186 4891.05002  1.37%     -    7s
*    0     0               0    4891.0500186 4891.05002  0.00%     -    7s

Cutting planes:
  Learned: 1
  Gomory: 3
  Cover: 2
  Implied bound: 7
  Clique: 3
  MIR: 4
  Flow cover: 7
  Zero half: 1
  RLT: 2
  Relax-and-lift: 1

Explored 1 nodes (1364 simplex iterations) in 7.77 seconds (7.30 work units)
Thread count was 8 (of 8 available processors)

Solution count 4: 4891.05 4825.05 3411.05 3035.05

Optimal solution found (tolerance 1.00e-08)
Best objective 4.891050018628e+03, best bound 4.891050018628e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□4891

  Itr = 0
Collect_LB =   [780.0]
Collect_UB =   [10562.10003725563]
Collect_Hua =   [0.0]
Collect_SPObjVal =   [4891.050018627815]
Collect_MPObjValNHua =   [780.0]


Set parameter TimeLimit to value 12000
Set parameter MIPGap to value 0.0005
Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)

CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
```

```
Optimize a model with 554091 rows, 283978 columns and 1537089 nonzeros
Model fingerprint: 0xc38fefd5
Variable types: 1 continuous, 283977 integer (283941 binary)
Coefficient statistics:
  Matrix range     [1e+00, 1e+10]
  Objective range  [1e+00, 2e+01]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 2e+10]
Warning: Model contains large matrix coefficients
Warning: Model contains large rhs
         Consider reformulating model or setting NumericFocus parameter
         to avoid numerical issues.
Presolve removed 395544 rows and 265240 columns (presolve time = 5s) ...
Presolve removed 502211 rows and 275364 columns (presolve time = 10s) ...
Presolve removed 502229 rows and 275364 columns
Presolve time: 10.20s
Presolved: 51862 rows, 8614 columns, 134659 nonzeros
Variable types: 0 continuous, 8614 integer (8587 binary)
Root relaxation presolved: 8614 rows, 60476 columns, 143273 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0      handle free variables                      11s
    6798    5.6710500e+03   0.000000e+00   0.000000e+00     12s
    6798    5.6710500e+03   0.000000e+00   0.000000e+00     12s

Root relaxation: objective 5.671050e+03, 6798 iterations, 1.09 seconds (1.80 work units)

    Nodes    |    Current Node    |     Objective Bounds      |     Work
 Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time

     0     0 5671.05002    0   57          - 5671.05002      -     -   12s
     0     0 5671.05002    0  204          - 5671.05002      -     -   14s
     0     0 5671.05002    0  262          - 5671.05002      -     -   15s
     0     0 5671.05002    0  190          - 5671.05002      -     -   15s
     0     0 5671.05002    0  175          - 5671.05002      -     -   15s
     0     0 5671.05002    0   29          - 5671.05002      -     -   17s
     0     0 5671.05002    0   33          - 5671.05002      -     -   17s
     0     0 5671.05002    0   26          - 5671.05002      -     -   18s
     0     0 5671.05002    0   89          - 5671.05002      -     -   18s
     0     0 5671.05002    0   89          - 5671.05002      -     -   18s
     0     0 5671.05002    0   35          - 5671.05002      -     -   19s
     0     0 5671.05002    0   93          - 5671.05002      -     -   19s
     0     0 5671.05002    0  201          - 5671.05002      -     -   20s
     0     0 5671.05002    0  196          - 5671.05002      -     -   20s
     0     0 5671.05002    0    1         - 5671.05002      -     -   22s
H    0     0                 6031.0500186 5671.05002  5.97%     -   22s
H    0     0                 5931.0500186 5671.05002  4.38%     -   22s
     0     0 5671.05002    0   71 5931.05002 5671.05002  4.38%     -   22s
     0     0 5671.05002    0   87 5931.05002 5671.05002  4.38%     -   22s
     0     0 5671.05002    0   75 5931.05002 5671.05002  4.38%     -   22s
     0     0 5671.05002    0   33 5931.05002 5671.05002  4.38%     -   25s
     0     0 5671.05002    0   31 5931.05002 5671.05002  4.38%     -   25s
     0     0 5671.05002    0   22 5931.05002 5671.05002  4.38%     -   25s
H    0     0                 5671.0500186 5671.05002  0.00%     -   26s
     0     0 5671.05002    0   22 5671.05002 5671.05002  0.00%     -   26s

Cutting planes:
  Learned: 2
  Gomory: 6
  Cover: 256
  Implied bound: 1717
  Clique: 2678
  MIR: 38
  StrongCG: 18
  GUB cover: 16
  Zero half: 2
  RLT: 19
  Relax-and-lift: 68
  BQP: 6

Explored 1 nodes (63444 simplex iterations) in 26.05 seconds (36.30 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 5671.05 5931.05 6031.05

Optimal solution found (tolerance 5.00e-04)
Best objective 5.671050018628e+03, best bound 5.671050018628e+03, gap 0.0000%
Set parameter MIPGap to value 1e-08
Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)

```

```
CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
Thread count: 4 physical cores, 8 logical processors, using up to 8 threads

Optimize a model with 2481733 rows, 1955335 columns and 17236336 nonzeros
Model fingerprint: 0x3d954fb3
Variable types: 963295 continuous, 992040 integer (985965 binary)
Coefficient statistics:
  Matrix range     [1e-01, 1e+10]
  Objective range  [6e-05, 5e+01]
  Bounds range     [1e+00, 8e+01]
  RHS range        [8e-01, 1e+10]
Warning: Model contains large matrix coefficients
Warning: Model contains large rhs
         Consider reformulating model or setting NumericFocus parameter
         to avoid numerical issues.
Presolve removed 2477006 rows and 1953719 columns (presolve time = 5s) ...
Presolve removed 2477012 rows and 1953719 columns
Presolve time: 5.55s
Presolved: 4721 rows, 1616 columns, 12482 nonzeros
Variable types: 8 continuous, 1608 integer (932 binary)
Found heuristic solution: objective 3527.0500186

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    1.0997452e+04   5.446083e+03   0.000000e+00      7s
    1508    5.3506703e+03   0.000000e+00   0.000000e+00      7s

Root relaxation: objective 5.350670e+03, 1508 iterations, 0.01 seconds (0.02 work units)

    Nodes    |    Current Node    |     Objective Bounds      |     Work
 Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time

     0     0 5350.67026    0    7 3527.05002 5350.67026  51.7%     -    7s
H    0     0                    5330.6702574 5350.67026  0.38%     -    7s
*    0     0               0    5350.6702574 5350.67026  0.00%     -    7s

Cutting planes:
  Gomory: 2
  Implied bound: 1
  Zero half: 4
  RLT: 1

Explored 1 nodes (2103 simplex iterations) in 7.46 seconds (7.05 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 5350.67 5330.67 3527.05

Optimal solution found (tolerance 1.00e-08)
Best objective 5.350670257367e+03, best bound 5.350670257367e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□5350

 Itr = 1
Collect_LB =   [780.0, 5671.050018627815]
Collect_UB =   [10562.10003725563, 6130.670257367259]
Collect_Hua =   [0.0, 4891.050018627815]
Collect_SPObjVal =   [4891.050018627815, 5350.670257367259]
Collect_MPObjValNHua =   [780.0, 780.0]


Set parameter TimeLimit to value 12000
Set parameter MIPGap to value 0.0005
Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)

CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
Thread count: 4 physical cores, 8 logical processors, using up to 8 threads

Optimize a model with 554092 rows, 283978 columns and 1537108 nonzeros
Model fingerprint: 0xc3c5a57b
Variable types: 1 continuous, 283977 integer (283941 binary)
Coefficient statistics:
  Matrix range     [1e+00, 1e+10]
  Objective range  [1e+00, 2e+01]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 2e+10]
Warning: Model contains large matrix coefficients
Warning: Model contains large rhs
         Consider reformulating model or setting NumericFocus parameter
         to avoid numerical issues.
Presolve removed 397441 rows and 265495 columns (presolve time = 5s) ...
Presolve removed 502687 rows and 275434 columns
Presolve time: 9.79s
Presolved: 51405 rows, 8544 columns, 132856 nonzeros
```

```
Variable types: 0 continuous, 8544 integer (8517 binary)
Root relaxation presolved: 8544 rows, 59949 columns, 141400 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0      handle free variables                      10s
    6478    6.1306703e+03   0.000000e+00   0.000000e+00     11s
    6478    6.1306703e+03   0.000000e+00   0.000000e+00     11s

Root relaxation: objective 6.130670e+03, 6478 iterations, 0.87 seconds (1.50 work units)

    Nodes    |    Current Node    |     Objective Bounds      |     Work
 Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time

     0     0 6130.67026    0    8          - 6130.67026      -     -   11s
     0     0 6130.67026    0   38          - 6130.67026      -     -   12s
     0     0 6130.67026    0   38          - 6130.67026      -     -   12s
     0     0 6130.67026    0   36          - 6130.67026      -     -   13s
     0     0 6130.67026    0   36          - 6130.67026      -     -   13s
     0     0 6130.67026    0  139          - 6130.67026      -     -   13s
     0     0 6130.67026    0  155          - 6130.67026      -     -   13s
     0     0 6130.67026    0    9          - 6130.67026      -     -   15s
     0     0 6130.67026    0    9          - 6130.67026      -     -   15s
     0     0 6130.67026    0    9          - 6130.67026      -     -   15s
H    0     0                    6130.6702574 6130.67026  0.00%     -   16s
     0     0 6130.67026    0    9 6130.67026 6130.67026  0.00%     -   16s

Cutting planes:
  Cover: 135
  Implied bound: 25
  Clique: 855
  MIR: 134
  StrongCG: 128
  GUB cover: 16
  Zero half: 2
  RLT: 4
  Relax-and-lift: 30
  BQP: 1

Explored 1 nodes (23210 simplex iterations) in 16.29 seconds (22.45 work units)
Thread count was 8 (of 8 available processors)

Solution count 1: 6130.67

Optimal solution found (tolerance 5.00e-04)
Best objective 6.130670257367e+03, best bound 6.130670257367e+03, gap 0.0000%
Set parameter MIPGap to value 1e-08
Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)

CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
Thread count: 4 physical cores, 8 logical processors, using up to 8 threads

Optimize a model with 2481733 rows, 1955335 columns and 17236336 nonzeros
Model fingerprint: 0xbcfc9c56
Variable types: 963295 continuous, 992040 integer (985965 binary)
Coefficient statistics:
  Matrix range     [1e-01, 1e+10]
  Objective range  [6e-05, 5e+01]
  Bounds range     [1e+00, 8e+01]
  RHS range        [8e-01, 1e+10]
Warning: Model contains large matrix coefficients
Warning: Model contains large rhs
         Consider reformulating model or setting NumericFocus parameter
         to avoid numerical issues.
Presolve removed 2477744 rows and 1953883 columns (presolve time = 5s) ...
Presolve removed 2477955 rows and 1953963 columns
Presolve time: 5.63s
Presolved: 3778 rows, 1372 columns, 10105 nonzeros
Variable types: 8 continuous, 1364 integer (805 binary)
Found heuristic solution: objective 3586.6702574

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    1.0793581e+04   5.063747e+03   0.000000e+00      7s
    1045    5.3894515e+03   0.000000e+00   0.000000e+00      7s

Root relaxation: objective 5.389451e+03, 1045 iterations, 0.01 seconds (0.01 work units)

    Nodes    |    Current Node    |     Objective Bounds      |     Work
 Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time

```

```
*    0     0               0    5389.4514539 5389.45145  0.00%     -    7s

Explored 1 nodes (1413 simplex iterations) in 7.45 seconds (7.01 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 5389.45 3586.67

Optimal solution found (tolerance 1.00e-08)
Best objective 5.389451453897e+03, best bound 5.389451453897e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□5389

 Itr = 2
Collect_LB =   [780.0, 5671.050018627815, 6130.670257367259]
Collect_UB =   [10562.10003725563, 6130.670257367259, 6130.670257367259]
Collect_Hua =   [0.0, 4891.050018627815, 5350.670257367259]
Collect_SPObjVal =   [4891.050018627815, 5350.670257367259, 5389.451453896585]
Collect_MPObjValNHua =   [780.0, 780.0, 780.0]


  Reach the termination conditions, stop iteration
  Values adopted from the Itr' th iteration, and Itr = {2}, judgeCount = {2}

~~~~~~~~~~judge = 2, SPObj_SPF = 5389.451453896585
Vessel i: 0:      pi: 1-6,      ai-di: 13-26,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 13-26,      taoi-deltai: 13-22,      taoPi_SP-deltaPi_SP: 13-22,      betaNi: 9,      bi: 9
Vessel i: 1:      pi: 6-12,      ai-di: 7-21,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 7-21,      taoi-deltai: 7-17,      taoPi_SP-deltaPi_SP: 7-17,      betaNi: 10,      bi: 10
Vessel i: 2:      pi: 6-11,      ai-di: 19-34,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 19-34,      taoi-deltai: 19-30,      taoPi_SP-deltaPi_SP: 19-30,      betaNi: 11,      bi: 11
Vessel i: 3:      pi: 3-9,      ai-di: 31-42,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 31-42,      taoi-deltai: 31-38,      taoPi_SP-deltaPi_SP: 31-38,      betaNi: 7,      bi: 7
Vessel i: 4:      pi: 4-11,      ai-di: 39-78,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 39-78,      taoi-deltai: 39-73,      taoPi_SP-deltaPi_SP: 39-73,      betaNi: 34,      bi: 34
Vessel i: 5:      pi: 14-20,      ai-di: 14-42,      gi_SP-gpi_SP: 0.000000-0.600000,      ai_SP-di: 14-42,      taoi-deltai: 14-24,      taoPi_SP-deltaPi_SP: 14-24,      betaNi: 10,      bi: 10
Vessel i: 6:      pi: 27-34,      ai-di: 17-74,      gi_SP-gpi_SP: 1.000000-0.000000,      ai_SP-di: 25-74,      taoi-deltai: 25-55,      taoPi_SP-deltaPi_SP: 25-55,      betaNi: 30,      bi: 30
Vessel i: 7:      pi: 18-23,      ai-di: 35-62,      gi_SP-gpi_SP: 0.800000-0.800000,      ai_SP-di: 43-62,      taoi-deltai: 39-46,      taoPi_SP-deltaPi_SP: 43-46,      betaNi: 7,      bi: 7
Vessel i: 8:      pi: 29-34,      ai-di: 51-79,      gi_SP-gpi_SP: 0.600000-1.000000,      ai_SP-di: 55-79,      taoi-deltai: 58-65,      taoPi_SP-deltaPi_SP: 58-65,      betaNi: 7,      bi: 7

round LB =   [780, 5671, 6131]
round UB =   [10562, 6131, 6131]
round Hua =   [0, 4891, 5351]
round SPObjVal =   [4891, 5351, 5389]
round MPObjValNHua =   [780, 780, 780]

OptimalObj = 6130.670257367259
Time: 549.000000
```