```
"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=43891

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 481534 rows, 46641 columns and 1344872 nonzeros
Model fingerprint: 0x3e7421da
Variable types: 1 continuous, 46640 integer (46608 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 262377 rows and 19927 columns (presolve time = 5s) ...
Presolve removed 424133 rows and 30617 columns
Presolve time: 8.20s
Presolved: 57401 rows, 16024 columns, 231304 nonzeros
Variable types: 0 continuous, 16024 integer (16000 binary)

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

Root relaxation presolved: 57396 rows, 16029 columns, 231289 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    8.4300000e+02   7.187500e+01   1.524365e+08      9s
Concurrent spin time: 0.03s

Solved with dual simplex (primal model)

Root relaxation: objective 8.430000e+02, 2419 iterations, 0.30 seconds (0.31 work units)

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

     0     0  843.00000    0   22          -  843.00000      -     -    9s
H    0     0                3883.0000000  843.00000  78.3%     -    9s
H    0     0                2023.0000000  843.00000  58.3%     -    9s
     0     0  843.00000    0  148 2023.00000  843.00000  58.3%     -   10s
H    0     0                1963.0000000  843.00000  57.1%     -   10s
     0     0  843.00000    0  148 1963.00000  843.00000  57.1%     -   10s
     0     0  843.00000    0   86 1963.00000  843.00000  57.1%     -   12s
     0     0  843.00000    0   80 1963.00000  843.00000  57.1%     -   12s
H    0     0                1323.0000000  843.00000  36.3%     -   12s
     0     0  843.00000    0   14 1323.00000  843.00000  36.3%     -   14s
     0     0  843.00000    0   19 1323.00000  843.00000  36.3%     -   14s
H    0     0                 883.0000000  843.00000  4.53%     -   14s
     0     0  843.00000    0   87  883.00000  843.00000  4.53%     -   15s
     0     0  843.00000    0   99  883.00000  843.00000  4.53%     -   15s
     0     0  843.00000    0   25  883.00000  843.00000  4.53%     -   20s
     0     0  843.00000    0  211  883.00000  843.00000  4.53%     -   20s
     0     0  843.00000    0  279  883.00000  843.00000  4.53%     -   20s
H    0     0                 843.0000000  843.00000  0.00%     -   21s

Cutting planes:
  Gomory: 9
  Lift-and-project: 2
  Cover: 46
  Implied bound: 3
  Clique: 21
```

```
  MIR: 28
  StrongCG: 18
  GUB cover: 10
  Zero half: 2
  RLT: 17
  Relax-and-lift: 54
  BQP: 3

Explored 1 nodes (30905 simplex iterations) in 21.59 seconds (36.73 work units)
Thread count was 8 (of 8 available processors)

Solution count 6: 843 883 1323 ... 3883

Optimal solution found (tolerance 1.00e-10)
Best objective 8.430000000000e+02, best bound 8.430000000000e+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 1983411 rows, 1559473 columns and 13693978 nonzeros
Model fingerprint: 0x1145fd22
Variable types: 766961 continuous, 792512 integer (787112 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 1978458 rows and 1557811 columns
Presolve time: 4.20s
Presolved: 4953 rows, 1662 columns, 13084 nonzeros
Variable types: 6 continuous, 1656 integer (953 binary)
Found heuristic solution: objective 3879.1111111
Found heuristic solution: objective 3899.1111111

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    1.1382000e+04   5.068677e+03   0.000000e+00      5s
    1590    5.6051111e+03   0.000000e+00   0.000000e+00      5s

Root relaxation: objective 5.605111e+03, 1590 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

H    0     0                    5605.1111111 15291.7778   173%     -    5s
     0     0        -    0      5605.11111 5605.11111  0.00%     -    5s

Explored 1 nodes (2002 simplex iterations) in 5.53 seconds (5.93 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 5605.11 3899.11 3879.11

Optimal solution found (tolerance 1.00e-08)
Best objective 5.605111111111e+03, best bound 5.605111111111e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□5605

  Itr = 0
Collect_LB =   [843.0]
Collect_UB =   [12053.222222222226]
Collect_Hua =   [0.0]
Collect_SPObjVal =   [5605.111111111113]
Collect_MPObjValNHua =   [843.0]


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 488881 rows, 229425 columns and 1352263 nonzeros
Model fingerprint: 0xf7c9e856
Variable types: 1 continuous, 229424 integer (229392 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 323492 rows and 211253 columns (presolve time = 5s) ...
Presolve removed 466035 rows and 221792 columns
Presolve time: 7.86s
Presolved: 22846 rows, 7633 columns, 95345 nonzeros
Variable types: 0 continuous, 7633 integer (7609 binary)

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    6.4481111e+03   9.100000e+02   0.000000e+00      8s
    3168    6.4481111e+03   0.000000e+00   0.000000e+00      8s

Root relaxation: objective 6.448111e+03, 3168 iterations, 0.06 seconds (0.08 work units)

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

     0     0 6448.11111    0   25          - 6448.11111      -     -    8s
     0     0 6448.11111    0  130          - 6448.11111      -     -    9s
     0     0 6448.11111    0  127          - 6448.11111      -     -    9s
     0     0 6448.11111    0  182          - 6448.11111      -     -    9s
     0     0 6448.11111    0  166          - 6448.11111      -     -    9s
     0     0 6448.11111    0   37          - 6448.11111      -     -   11s
     0     0 6448.11111    0   72          - 6448.11111      -     -   11s
     0     0 6448.11111    0   25          - 6448.11111      -     -   12s
     0     0 6448.11111    0   48          - 6448.11111      -     -   12s
     0     0 6448.11111    0  361          - 6448.11111      -     -   13s
     0     0 6448.11111    0  360          - 6448.11111      -     -   13s
     0     0 6448.11111    0   50          - 6448.11111      -     -   13s
     0     0 6448.11111    0   50          - 6448.11111      -     -   14s
     0     2 6448.11111    0   50          - 6448.11111      -     -   15s
    23    26 6448.11111    6  407          - 6448.11111      -  2894   20s
    88   117 6448.11111   17  270          - 6448.11111      -  1847   26s
   169   203 6448.11111   36  217          - 6448.11111      -  1350   30s
H  226   203                6448.1111111 6448.11111  0.00%  1101   30s

Cutting planes:
  Learned: 4
  Gomory: 3
  Cover: 509
  Implied bound: 991
  Clique: 958
  MIR: 186
  StrongCG: 157
  GUB cover: 32
  Zero half: 11
  RLT: 7
  Relax-and-lift: 15
  BQP: 10

Explored 281 nodes (346551 simplex iterations) in 30.17 seconds (61.74 work units)
Thread count was 8 (of 8 available processors)

Solution count 1: 6448.11

Optimal solution found (tolerance 5.00e-04)
Best objective 6.448111111111e+03, best bound 6.448111111111e+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 1983411 rows, 1559473 columns and 13693978 nonzeros
Model fingerprint: 0x5c8faad8
Variable types: 766961 continuous, 792512 integer (787112 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 1977950 rows and 1557665 columns
Presolve time: 3.98s
```

```
Presolved: 5461 rows, 1808 columns, 14589 nonzeros
Variable types: 6 continuous, 1802 integer (1046 binary)

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    1.1268000e+04   6.599738e+03   0.000000e+00      5s
    1429    5.7831111e+03   0.000000e+00   0.000000e+00      5s

Root relaxation: objective 5.783111e+03, 1429 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               0    5783.1111111 5783.11111  0.00%     -    5s

Explored 1 nodes (1957 simplex iterations) in 5.32 seconds (5.50 work units)
Thread count was 8 (of 8 available processors)

Solution count 1: 5783.11

Optimal solution found (tolerance 1.00e-08)
Best objective 5.783111111111e+03, best bound 5.783111111111e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□5783

 Itr = 1
Collect_LB =   [843.0, 6448.111111111113]
Collect_UB =   [12053.222222222226, 6626.111111111113]
Collect_Hua =   [0.0, 5605.111111111113]
Collect_SPObjVal =   [5605.111111111113, 5783.111111111113]
Collect_MPObjValNHua =   [843.0, 843.0]


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 488882 rows, 229425 columns and 1352280 nonzeros
Model fingerprint: 0x311fa47e
Variable types: 1 continuous, 229424 integer (229392 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 323493 rows and 211253 columns (presolve time = 5s) ...
Presolve removed 466036 rows and 221792 columns
Presolve time: 7.72s
Presolved: 22846 rows, 7633 columns, 95345 nonzeros
Variable types: 0 continuous, 7633 integer (7609 binary)

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    6.6261111e+03   9.100000e+02   0.000000e+00      8s
    3168    6.6261111e+03   0.000000e+00   0.000000e+00      8s

Root relaxation: objective 6.626111e+03, 3168 iterations, 0.06 seconds (0.08 work units)

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

     0     0 6626.11111    0   25          - 6626.11111      -     -    8s
     0     0 6626.11111    0  130          - 6626.11111      -     -    9s
     0     0 6626.11111    0  127          - 6626.11111      -     -    9s
     0     0 6626.11111    0  182          - 6626.11111      -     -    9s
     0     0 6626.11111    0  166          - 6626.11111      -     -    9s
     0     0 6626.11111    0   37          - 6626.11111      -     -   11s
     0     0 6626.11111    0   72          - 6626.11111      -     -   11s
     0     0 6626.11111    0   25          - 6626.11111      -     -   12s
     0     0 6626.11111    0   48          - 6626.11111      -     -   12s
     0     0 6626.11111    0  361          - 6626.11111      -     -   12s
     0     0 6626.11111    0  360          - 6626.11111      -     -   12s
     0     0 6626.11111    0   50          - 6626.11111      -     -   13s
     0     0 6626.11111    0   50          - 6626.11111      -     -   13s
     0     2 6626.11111    0   50          - 6626.11111      -     -   15s
```

```
     39    42 6626.11111    9  408          - 6626.11111      -  1906   20s
     120   145 6635.58480   24  246          - 6626.11111      -  1634   26s
     219   279 8466.11111   61  370          - 6626.11111      -  1227   30s
     679   595 6626.11111    8  550          - 6626.11111      -   556   35s
     992   708 6626.11111   36  193          - 6626.11111      -   479   41s
    1068  1017 6626.11111   51  491          - 6626.11111      -   523   45s
  * 1470   793             186    7086.1111111 6626.11111  6.49%   449   49s
    1954   559 6626.11111   98   50 7086.11111 6626.11111  6.49%   399   58s
    1957   561 6626.11111   52  203 7086.11111 6626.11111  6.49%   398   61s
    1959   562 6766.11111  120  194 7086.11111 6626.11111  6.49%   398   65s
    1962   564 6626.11111   52  627 7086.11111 6626.11111  6.49%   397   70s
  H 1962   535                  7026.1111111 6626.11111  5.69%   397   72s
  H 1963   509                  6626.1111111 6626.11111  0.00%   397   73s

Cutting planes:
  Gomory: 11
  Cover: 345
  Implied bound: 58
  Projected implied bound: 15
  Clique: 54
  MIR: 20
  StrongCG: 8
  Flow cover: 16
  GUB cover: 67
  Zero half: 19
  RLT: 17
  Relax-and-lift: 39
  BQP: 3

Explored 1963 nodes (879924 simplex iterations) in 73.88 seconds (145.47 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 6626.11 7026.11 7086.11

Optimal solution found (tolerance 5.00e-04)
Best objective 6.626111111111e+03, best bound 6.626111111111e+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 1983411 rows, 1559473 columns and 13693978 nonzeros
Model fingerprint: 0x6bd04ca5
Variable types: 766961 continuous, 792512 integer (787112 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 1977523 rows and 1557586 columns
Presolve time: 4.15s
Presolved: 5888 rows, 1887 columns, 15718 nonzeros
Variable types: 6 continuous, 1881 integer (1082 binary)

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    1.1388000e+04   7.654648e+03   0.000000e+00      5s
    1510    5.7831111e+03   0.000000e+00   0.000000e+00      5s

Root relaxation: objective 5.783111e+03, 1510 iterations, 0.02 seconds (0.02 work units)

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

H    0     0                    5783.1111111 16897.7778   192%     -    5s
     0     0        -    0      5783.11111 5783.11111  0.00%     -    5s

Explored 1 nodes (2001 simplex iterations) in 5.62 seconds (5.69 work units)
Thread count was 8 (of 8 available processors)

Solution count 1: 5783.11

Optimal solution found (tolerance 1.00e-08)
Best objective 5.783111111111e+03, best bound 5.783111111111e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□5783

 Itr = 2
```

```
Collect_LB =   [843.0, 6448.111111111113, 6626.111111111113]
Collect_UB =   [12053.222222222226, 6626.111111111113, 6626.111111111113]
Collect_Hua =   [0.0, 5605.111111111113, 5783.111111111113]
Collect_SPObjVal =   [5605.111111111113, 5783.111111111113, 5783.111111111113]
Collect_MPObjValNHua =   [843.0, 843.0, 843.0]


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

~~~~~~~~~~judge = 2, SPObj_SPF = 5783.111111111113
Vessel i: 0:     pi: 0-7,     ai-di: 3-34,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 3-34,     taoi-deltai: 3-32,     taoPi_SP-deltaPi_SP: 3-32,     betaNi: 29
,     bi: 29
Vessel i: 1:     pi: 7-12,     ai-di: 12-22,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 12-22,     taoi-deltai: 12-20,     taoPi_SP-deltaPi_SP: 12-20,     betaNi
: 8,     bi: 8
Vessel i: 2:     pi: 14-19,     ai-di: 27-35,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 27-35,     taoi-deltai: 27-33,     taoPi_SP-deltaPi_SP: 27-33,
betaNi: 6,     bi: 6
Vessel i: 3:     pi: 7-14,     ai-di: 24-60,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 24-60,     taoi-deltai: 24-58,     taoPi_SP-deltaPi_SP: 24-58,     betaNi
: 34,     bi: 34
Vessel i: 4:     pi: 15-20,     ai-di: 35-41,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 35-41,     taoi-deltai: 35-39,     taoPi_SP-deltaPi_SP: 35-39,
betaNi: 4,     bi: 4
Vessel i: 5:     pi: 28-34,     ai-di: 31-60,     gi_SP-gpi_SP: 0.000000-1.000000,     ai_SP-di: 31-60,     taoi-deltai: 31-46,     taoPi_SP-deltaPi_SP: 31-46,
betaNi: 15,     bi: 15
Vessel i: 6:     pi: 15-21,     ai-di: 40-80,     gi_SP-gpi_SP: 1.000000-0.600000,     ai_SP-di: 48-80,     taoi-deltai: 48-72,     taoPi_SP-deltaPi_SP: 48-72,
betaNi: 24,     bi: 24
Vessel i: 7:     pi: 28-34,     ai-di: 43-72,     gi_SP-gpi_SP: 0.800000-0.200000,     ai_SP-di: 51-72,     taoi-deltai: 51-64,     taoPi_SP-deltaPi_SP: 51-64,
betaNi: 13,     bi: 13

round LB =   [843, 6448, 6626]
round UB =   [12053, 6626, 6626]
round Hua =   [0, 5605, 5783]
round SPObjVal =   [5605, 5783, 5783]
round MPObjValNHua =   [843, 843, 843]

OptimalObj = 6626.111111111113
Time: 486.000000
```