```
"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=3914

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 418250 rows, 34789 columns and 1145784 nonzeros
Model fingerprint: 0xa9858bea
Variable types: 1 continuous, 34788 integer (34764 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 216139 rows and 12332 columns (presolve time = 5s) ...
Presolve removed 376302 rows and 22665 columns
Presolve time: 7.82s
Presolved: 41948 rows, 12124 columns, 174170 nonzeros
Variable types: 0 continuous, 12124 integer (12106 binary)

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

Root relaxation presolved: 41941 rows, 12131 columns, 174149 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    7.0700000e+02   8.037500e+01   1.732803e+08      8s
Concurrent spin time: 0.00s

Solved with dual simplex (primal model)

Root relaxation: objective 7.070000e+02, 2082 iterations, 0.25 seconds (0.28 work units)

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

     0     0  707.00000    0    7          -  707.00000      -     -    8s
H    0     0                     907.0000000  707.00000  22.1%     -    8s
     0     0  707.00000    0   15  907.00000  707.00000  22.1%     -    9s
H    0     0                     707.0000000  707.00000  0.00%     -   12s
     0     0  707.00000    0   30  707.00000  707.00000  0.00%     -   12s

Explored 1 nodes (8613 simplex iterations) in 12.30 seconds (22.87 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 707 907

Optimal solution found (tolerance 1.00e-10)
Best objective 7.070000000000e+02, best bound 7.070000000000e+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 1153929 rows, 901813 columns and 7830092 nonzeros
Model fingerprint: 0xaca7330c
Variable types: 441325 continuous, 460488 integer (456438 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 1151590 rows and 900949 columns
Presolve time: 2.51s
Presolved: 2339 rows, 864 columns, 6249 nonzeros
Variable types: 4 continuous, 860 integer (499 binary)
Found heuristic solution: objective 2985.6639543

Root relaxation: objective 4.300667e+03, 681 iterations, 0.02 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    4300.6666667 4300.66667  0.00%     -    3s

Explored 1 nodes (681 simplex iterations) in 3.24 seconds (3.54 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 4300.67 2985.66

Optimal solution found (tolerance 1.00e-08)
Best objective 4.300666666667e+03, best bound 4.300666666667e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□4300

  Itr = 0
Collect_LB =   [707.0]
Collect_UB =   [9308.333333333336]
Collect_Hua =   [0.0]
Collect_SPObjVal =   [4300.666666666668]
Collect_MPObjValNHua =   [707.0]


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 422318 rows, 137605 columns and 1149879 nonzeros
Model fingerprint: 0xee3e97bf
Variable types: 1 continuous, 137604 integer (137580 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 250143 rows and 119726 columns (presolve time = 5s) ...
Presolve removed 399036 rows and 130133 columns
Presolve time: 9.17s
Presolved: 23282 rows, 7472 columns, 100054 nonzeros
Variable types: 0 continuous, 7472 integer (7454 binary)

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    5.0076667e+03   7.540000e+02   0.000000e+00      9s
    3666    5.0076667e+03   0.000000e+00   0.000000e+00      9s

Root relaxation: objective 5.007667e+03, 3666 iterations, 0.09 seconds (0.11 work units)

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

     0     0 5007.66667    0   18          - 5007.66667      -     -    9s
H    0     0                6507.6666667 5007.66667  23.0%     -   10s
H    0     0                6407.6666667 5007.66667  21.8%     -   10s
     0     0 5007.66667    0  125 6407.66667 5007.66667  21.8%     -   10s
     0     0 5007.66667    0   95 6407.66667 5007.66667  21.8%     -   10s
     0     0 5007.66667    0  169 6407.66667 5007.66667  21.8%     -   11s
     0     0 5007.66667    0  183 6407.66667 5007.66667  21.8%     -   12s
     0     0 5007.66667    0  321 6407.66667 5007.66667  21.8%     -   13s
     0     0 5007.66667    0  256 6407.66667 5007.66667  21.8%     -   13s
     0     0 5007.66667    0  111 6407.66667 5007.66667  21.8%     -   15s
     0     0 5007.66667    0   84 6407.66667 5007.66667  21.8%     -   15s
```

```
     0     0 5007.66667    0   49 6407.66667 5007.66667  21.8%     -   16s
     0     2 5007.66667    0   46 6407.66667 5007.66667  21.8%     -   17s
     7    10 5007.66667    3  106 6407.66667 5007.66667  21.8%  2293   20s
    28    27 5007.66667    6  289 6407.66667 5007.66667  21.8%  2570   25s
    93    69 5128.52111   22 1193 6407.66667 5007.66667  21.8%  1889   31s
H  202   128                5887.6666667 5007.66667  14.9%  1386   34s
   227   207 5007.66667   61  144 5887.66667 5007.66667  14.9%  1363   39s
   357   468 5007.66667   94  403 5887.66667 5007.66667  14.9%  1195   48s
   749   852 infeasible  158      5887.66667 5007.66667  14.9%   840   55s
  1278  1509 5067.66667  326  945 5887.66667 5007.66667  14.9%   610   60s
* 1561  1095             309    5207.6666667 5007.66667  3.84%   536   60s
  2233   635 5027.66667  404   49 5207.66667 5007.66667  3.84%   423   67s
  2238   638 5107.66667  101  484 5207.66667 5007.66667  3.84%   422   70s
H 2241   607                5127.6666667 5007.66667  2.34%   421   75s

Cutting planes:
  Gomory: 13
  Cover: 339
  Implied bound: 334
  Projected implied bound: 456
  Clique: 179
  MIR: 153
  StrongCG: 110
  Flow cover: 188
  GUB cover: 56
  Zero half: 14
  RLT: 4
  Relax-and-lift: 176
  BQP: 5

Explored 2244 nodes (1038432 simplex iterations) in 79.39 seconds (167.79 work units)
Thread count was 8 (of 8 available processors)

Solution count 5: 5127.67 5207.67 5887.67 ... 6507.67

Optimal solution found (tolerance 5.00e-04)
Best objective 5.127666666667e+03, best bound 5.127666666667e+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 1153929 rows, 901813 columns and 7830092 nonzeros
Model fingerprint: 0x3d6a0be7
Variable types: 441325 continuous, 460488 integer (456438 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 1149196 rows and 900304 columns
Presolve time: 2.42s
Presolved: 4733 rows, 1509 columns, 12713 nonzeros
Variable types: 4 continuous, 1505 integer (872 binary)
Found heuristic solution: objective 3164.6666667

Root relaxation: objective 4.562667e+03, 1278 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                4562.6666667 13320.0000   192%     -    3s
     0     0        -    0     4562.66667 4562.66667  0.00%     -    3s

Explored 1 nodes (1939 simplex iterations) in 3.20 seconds (3.27 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 4562.67 3164.67

Optimal solution found (tolerance 1.00e-08)
Best objective 4.562666666667e+03, best bound 4.562666666667e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□4562

 Itr = 1
Collect_LB =   [707.0, 5127.666666666668]
Collect_UB =   [9308.333333333336, 5389.666666666668]
Collect_Hua =   [0.0, 4300.666666666668]
Collect_SPObjVal =   [4300.666666666668, 4562.666666666668]
```

```
Collect_MPObjValNHua =   [707.0, 827.0]


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 422319 rows, 137605 columns and 1149892 nonzeros
Model fingerprint: 0x0dd00630
Variable types: 1 continuous, 137604 integer (137580 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 250143 rows and 119725 columns (presolve time = 5s) ...
Presolve removed 399036 rows and 130132 columns
Presolve time: 8.85s
Presolved: 23283 rows, 7473 columns, 100061 nonzeros
Variable types: 0 continuous, 7473 integer (7454 binary)

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    2.0696667e+03   9.251875e+02   0.000000e+00      9s
    2754    5.3696667e+03   0.000000e+00   0.000000e+00      9s

Root relaxation: objective 5.369667e+03, 2754 iterations, 0.35 seconds (0.83 work units)
Total elapsed time = 10.04s

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

     0     0 5369.66667    0   11          - 5369.66667      -     -   10s
     0     0 5369.66667    0  118          - 5369.66667      -     -   11s
     0     0 5369.66667    0  265          - 5369.66667      -     -   11s
     0     0 5369.66667    0   66          - 5369.66667      -     -   12s
     0     0 5369.66667    0  310          - 5369.66667      -     -   13s
     0     0 5369.66667    0  301          - 5369.66667      -     -   13s
H    0     0                 5549.6666667 5369.66667  3.24%     -   14s
     0     0 5369.66667    0   26 5549.66667 5369.66667  3.24%     -   14s
     0     0 5369.66667    0  104 5549.66667 5369.66667  3.24%     -   14s
     0     0 5369.66667    0  215 5549.66667 5369.66667  3.24%     -   15s
     0     0 5369.66667    0  380 5549.66667 5369.66667  3.24%     -   15s
     0     0 5369.66667    0  436 5549.66667 5369.66667  3.24%     -   15s
     0     0 5369.66667    0   15 5549.66667 5369.66667  3.24%     -   17s
     0     0 5369.66667    0  258 5549.66667 5369.66667  3.24%     -   17s
     0     0 5369.66667    0  257 5549.66667 5369.66667  3.24%     -   17s
     0     0 5369.66667    0  303 5549.66667 5369.66667  3.24%     -   17s
     0     0 5369.66667    0  117 5549.66667 5369.66667  3.24%     -   18s
     0     0 5369.66667    0  398 5549.66667 5369.66667  3.24%     -   18s
     0     0 5369.66667    0  307 5549.66667 5369.66667  3.24%     -   19s
     0     0 5369.66667    0  305 5549.66667 5369.66667  3.24%     -   19s
     0     0 5369.66667    0  242 5549.66667 5369.66667  3.24%     -   20s
H    0     0                 5469.6666667 5369.66667  1.83%     -   20s
     0     0 5369.66667    0   14 5469.66667 5369.66667  1.83%     -   21s
     0     0 5369.66667    0  292 5469.66667 5369.66667  1.83%     -   21s
     0     0 5369.66667    0  285 5469.66667 5369.66667  1.83%     -   21s
     0     0 5369.66667    0  275 5469.66667 5369.66667  1.83%     -   21s
     0     0 5369.66667    0  151 5469.66667 5369.66667  1.83%     -   22s
     0     0 5369.66667    0  139 5469.66667 5369.66667  1.83%     -   22s
     0     0 5369.66667    0  599 5469.66667 5369.66667  1.83%     -   22s
     0     0 5369.66667    0  578 5469.66667 5369.66667  1.83%     -   22s
     0     0 5369.66667    0  180 5469.66667 5369.66667  1.83%     -   24s
     0     0 5369.66667    0  179 5469.66667 5369.66667  1.83%     -   24s
     0     0 5369.66667    0  179 5469.66667 5369.66667  1.83%     -   24s
     0     2 5369.66667    0  179 5469.66667 5369.66667  1.83%     -   25s
   295   217 5369.66667   43  358 5469.66667 5369.66667  1.83%   326   30s
  1045   648 5429.66667   46  436 5469.66667 5369.66667  1.83%   221   39s
  1047   649 5382.92077  160   36 5469.66667 5369.66667  1.83%   221   40s
  1050   651 5409.66667   80  575 5469.66667 5369.66667  1.83%   220   45s
  1052   653 5369.66667  106  612 5469.66667 5369.66667  1.83%   220   50s
H 1053   620                 5449.6666667 5369.66667  1.47%   220   55s
H 1053   589                 5409.6666667 5369.66667  0.74%   220   55s
H 1055   561                 5389.6666667 5369.66667  0.37%   219   59s
  1056   561 5369.66667   30  636 5389.66667 5369.66667  0.37%   219   60s
  1060   564 5372.56857  145  757 5389.66667 5369.66667  0.37%   218   65s
```

```
 1064   567 5389.66667   52  766 5389.66667 5369.66667  0.37%   217   71s
 1069   571 5369.66667   30  436 5389.66667 5369.66667  0.37%   288   76s
 1075   575 5369.66667   54  708 5389.66667 5369.66667  0.37%   287   81s
 1078   577 5389.66667   11  758 5389.66667 5369.66667  0.37%   286   86s

Cutting planes:
  Gomory: 6
  Cover: 387
  Implied bound: 82
  Projected implied bound: 152
  Clique: 102
  MIR: 35
  StrongCG: 13
  Flow cover: 354
  GUB cover: 73
  Zero half: 126
  RLT: 9
  Relax-and-lift: 158
  BQP: 2

Explored 1081 nodes (417610 simplex iterations) in 89.93 seconds (119.89 work units)
Thread count was 8 (of 8 available processors)

Solution count 5: 5389.67 5409.67 5449.67 ... 5549.67

Optimal solution found (tolerance 5.00e-04)
Best objective 5.389666666667e+03, best bound 5.389666666667e+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 1153929 rows, 901813 columns and 7830092 nonzeros
Model fingerprint: 0x9fa1e7fd
Variable types: 441325 continuous, 460488 integer (456438 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 1149327 rows and 900340 columns
Presolve time: 2.46s
Presolved: 4602 rows, 1473 columns, 12351 nonzeros
Variable types: 4 continuous, 1469 integer (846 binary)
Found heuristic solution: objective 3125.6666667
Found heuristic solution: objective 3263.6666667

Root relaxation: objective 4.520667e+03, 1332 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

     0     0 4520.66667    0   10 3263.66667 4520.66667  38.5%     -    3s
H    0     0                    4520.6666667 4520.66667  0.00%     -    3s
     0     0 4520.66667    0   10 4520.66667 4520.66667  0.00%     -    3s

Explored 1 nodes (1890 simplex iterations) in 3.27 seconds (3.45 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 4520.67 3263.67 3125.67

Optimal solution found (tolerance 1.00e-08)
Best objective 4.520666666667e+03, best bound 4.520666666667e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□4520

 Itr = 2
Collect_LB =   [707.0, 5127.666666666668, 5389.666666666666]
Collect_UB =   [9308.333333333336, 5389.666666666668, 5347.666666666668]
Collect_Hua =   [0.0, 4300.666666666668, 4562.666666666666]
Collect_SPObjVal =   [4300.666666666668, 4562.666666666668, 4520.666666666668]
Collect_MPObjValNHua =   [707.0, 827.0, 827.0]


 Ops, stop iteration
 Values adopted from the Itr-1' th iteration, and Itr = {2}, judgeCount = {1}

~~~~~~~~~~judgeCount = 1, SPObj_SPF = 4562.666666666668
Vessel i: 0:      pi: 0-7,      ai-di: 5-27,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 5-27,      taoi-deltai: 5-15,      taoPi_SP-deltaPi_SP: 5-15,      betaNi: 10
```

```
,      bi: 10
Vessel i: 1:      pi: 7-13,      ai-di: 11-28,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 11-28,      taoi-deltai: 11-16,      taoPi_SP-deltaPi_SP: 11-16,      betaNi: 5,      bi: 5
Vessel i: 2:      pi: 13-20,      ai-di: 13-54,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 13-54,      taoi-deltai: 13-42,      taoPi_SP-deltaPi_SP: 13-42,      betaNi: 29,      bi: 29
Vessel i: 3:      pi: 7-13,      ai-di: 33-64,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 33-64,      taoi-deltai: 33-52,      taoPi_SP-deltaPi_SP: 33-52,      betaNi: 19,      bi: 19
Vessel i: 4:      pi: 20-27,      ai-di: 27-65,      gi_SP-gpi_SP: 0.200000-1.000000,      ai_SP-di: 28-65,      taoi-deltai: 28-54,      taoPi_SP-deltaPi_SP: 28-54,      betaNi: 26,      bi: 26
Vessel i: 5:      pi: 14-20,      ai-di: 30-60,      gi_SP-gpi_SP: 1.000000-0.200000,      ai_SP-di: 38-60,      taoi-deltai: 43-61,      taoPi_SP-deltaPi_SP: 43-61,      betaNi: 18,      bi: 18

round LB =   [707, 5128, 5390]
round UB =   [9308, 5390, 5348]
round Hua =   [0, 4301, 4563]
round SPObjVal =   [4301, 4563, 4521]
round MPObjValNHua =   [707, 827, 827]

OptimalObj = 5389.666666666666
Time: 405.000000
```