```
"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=9450

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 360923 rows, 34789 columns and 1002717 nonzeros
Model fingerprint: 0xa61a2c1f
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 176910 rows and 12747 columns (presolve time = 5s) ...
Presolve removed 307571 rows and 21407 columns
Presolve time: 6.26s
Presolved: 53352 rows, 13382 columns, 204541 nonzeros
Variable types: 0 continuous, 13382 integer (13364 binary)

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

Root relaxation presolved: 53351 rows, 13383 columns, 204538 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    1.1240000e+03   9.687500e+01   1.931714e+08      7s
Concurrent spin time: 0.01s

Solved with dual simplex (primal model)

Root relaxation: objective 8.040000e+02, 1859 iterations, 0.27 seconds (0.23 work units)

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

     0     0  804.00000    0    2          -  804.00000      -     -    7s
H    0     0                2244.0000000  804.00000  64.2%     -    7s
H    0     0                1364.0000000  804.00000  41.1%     -    7s
     0     0  804.00000    0   19 1364.00000  804.00000  41.1%     -    8s
H    0     0                 804.0000000  804.00000  0.00%     -    9s
     0     0  804.00000    0    7  804.00000  804.00000  0.00%     -    9s

Cutting planes:
  Cover: 122
  Implied bound: 610
  Clique: 3
  MIR: 4
  StrongCG: 3
  GUB cover: 1
  Zero half: 2
  Relax-and-lift: 19

Explored 1 nodes (13323 simplex iterations) in 9.39 seconds (15.78 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 804 1364 2244

Optimal solution found (tolerance 1.00e-10)
Best objective 8.040000000000e+02, best bound 8.040000000000e+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 1153863 rows, 901813 columns and 7829828 nonzeros
Model fingerprint: 0xf22978a3
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 1151492 rows and 900957 columns
Presolve time: 2.54s
Presolved: 2371 rows, 856 columns, 6316 nonzeros
Variable types: 0 continuous, 856 integer (503 binary)
Found heuristic solution: objective 4207.6666667

Root relaxation: objective 5.149667e+03, 652 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    5149.6666667 5149.66667  0.00%     -    3s

Explored 1 nodes (652 simplex iterations) in 3.28 seconds (3.48 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 5149.67 4207.67

Optimal solution found (tolerance 1.00e-08)
Best objective 5.149666666667e+03, best bound 5.149666666667e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□5149

  Itr = 0
Collect_LB =   [804.0]
Collect_UB =   [11103.333333333336]
Collect_Hua =   [0.0]
Collect_SPObjVal =   [5149.666666666668]
Collect_MPObjValNHua =   [804.0]


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 367235 rows, 137605 columns and 1009056 nonzeros
Model fingerprint: 0x970e3d5f
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 229130 rows and 122378 columns (presolve time = 5s) ...
Presolve removed 343025 rows and 131193 columns
Presolve time: 6.11s
Presolved: 24210 rows, 6412 columns, 85890 nonzeros
Variable types: 0 continuous, 6412 integer (6395 binary)

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    6.0736667e+03   8.510000e+02   0.000000e+00      6s
    2440    6.0736667e+03   0.000000e+00   0.000000e+00      6s

Root relaxation: objective 6.073667e+03, 2440 iterations, 0.07 seconds (0.14 work units)

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

```
164       0     0 6073.66667    0    9          - 6073.66667      -     -    6s
165       0     0 6073.66667    0    8          - 6073.66667      -     -    6s
166       0     0 6073.66667    0  109          - 6073.66667      -     -    7s
167       0     0 6073.66667    0  101          - 6073.66667      -     -    7s
168       0     0 6073.66667    0  156          - 6073.66667      -     -    7s
169       0     0 6073.66667    0  146          - 6073.66667      -     -    7s
170       0     0 6073.66667    0   13          - 6073.66667      -     -    7s
171       0     0 6073.66667    0   20          - 6073.66667      -     -    8s
172       0     0 6073.66667    0    1          - 6073.66667      -     -    8s
173       0     0 6073.66667    0   13          - 6073.66667      -     -    8s
174       0     0 6073.66667    0    1          - 6073.66667      -     -    8s
175       0     0 6073.66667    0    1          - 6073.66667      -     -    9s
176  H    0     0                    6073.6666667 6073.66667  0.00%     -    9s
177       0     0 6073.66667    0    1 6073.66667 6073.66667  0.00%     -    9s
178
179  Cutting planes:
180    Gomory: 2
181    Cover: 229
182    Implied bound: 510
183    Clique: 145
184    MIR: 24
185    StrongCG: 15
186    GUB cover: 35
187    RLT: 1
188    Relax-and-lift: 11
189
190  Explored 1 nodes (17849 simplex iterations) in 9.27 seconds (13.47 work units)
191  Thread count was 8 (of 8 available processors)
192
193  Solution count 1: 6073.67
194
195  Optimal solution found (tolerance 5.00e-04)
196  Best objective 6.073666666667e+03, best bound 6.073666666667e+03, gap 0.0000%
197  Set parameter MIPGap to value 1e-08
198  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
199
200  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
201  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
202
203  Optimize a model with 1153863 rows, 901813 columns and 7829828 nonzeros
204  Model fingerprint: 0xf3ef7702
205  Variable types: 441325 continuous, 460488 integer (456438 binary)
206  Coefficient statistics:
207    Matrix range     [1e-01, 1e+10]
208    Objective range  [6e-05, 5e+01]
209    Bounds range     [1e+00, 8e+01]
210    RHS range        [8e-01, 1e+10]
211  Warning: Model contains large matrix coefficients
212  Warning: Model contains large rhs
213           Consider reformulating model or setting NumericFocus parameter
214           to avoid numerical issues.
215  Presolve removed 1148580 rows and 900032 columns
216  Presolve time: 2.30s
217  Presolved: 5283 rows, 1781 columns, 14070 nonzeros
218  Variable types: 4 continuous, 1777 integer (1024 binary)
219  Found heuristic solution: objective 3689.6666667
220
221  Root relaxation: objective 5.402667e+03, 1412 iterations, 0.02 seconds (0.01 work units)
222
223      Nodes    |    Current Node    |     Objective Bounds      |     Work
224   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
225
226  H    0     0                    5402.6666667 15700.0000   191%     -    2s
227       0     0          -    0     5402.66667 5402.66667  0.00%     -    2s
228
229  Explored 1 nodes (1853 simplex iterations) in 3.03 seconds (3.27 work units)
230  Thread count was 8 (of 8 available processors)
231
232  Solution count 2: 5402.67 3689.67
233
234  Optimal solution found (tolerance 1.00e-08)
235  Best objective 5.402666666667e+03, best bound 5.402666666667e+03, gap 0.0000%
236  SP is solved
237  SP's optimal solution is'□5402
238
239   Itr = 1
240  Collect_LB =   [804.0, 6073.666666666668]
241  Collect_UB =   [11103.333333333336, 6326.666666666668]
242  Collect_Hua =   [0.0, 5149.666666666668]
243  Collect_SPObjVal =   [5149.666666666668, 5402.666666666668]
244  Collect_MPObjValNHua =   [804.0, 924.0]
245
246
247  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 367236 rows, 137605 columns and 1009069 nonzeros
Model fingerprint: 0x2ce99282
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 229131 rows and 122378 columns (presolve time = 5s) ...
Presolve removed 343026 rows and 131193 columns
Presolve time: 6.03s
Presolved: 24210 rows, 6412 columns, 85890 nonzeros
Variable types: 0 continuous, 6412 integer (6395 binary)

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    6.3266667e+03   8.510000e+02   0.000000e+00      6s
    2440    6.3266667e+03   0.000000e+00   0.000000e+00      6s

Root relaxation: objective 6.326667e+03, 2440 iterations, 0.08 seconds (0.14 work units)

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

     0     0 6326.66667    0    9          - 6326.66667      -     -    6s
     0     0 6326.66667    0    8          - 6326.66667      -     -    6s
     0     0 6326.66667    0  109          - 6326.66667      -     -    7s
     0     0 6326.66667    0  101          - 6326.66667      -     -    7s
     0     0 6326.66667    0  156          - 6326.66667      -     -    7s
     0     0 6326.66667    0  146          - 6326.66667      -     -    7s
     0     0 6326.66667    0   13          - 6326.66667      -     -    7s
     0     0 6326.66667    0   20          - 6326.66667      -     -    8s
     0     0 6326.66667    0    1          - 6326.66667      -     -    8s
     0     0 6326.66667    0   13          - 6326.66667      -     -    8s
     0     0 6326.66667    0    1          - 6326.66667      -     -    9s
     0     0 6326.66667    0    1          - 6326.66667      -     -    9s
H    0     0                    6326.6666667 6326.66667  0.00%     -    9s
     0     0 6326.66667    0    1 6326.66667 6326.66667  0.00%     -    9s

Cutting planes:
  Gomory: 2
  Cover: 229
  Implied bound: 510
  Clique: 145
  MIR: 24
  StrongCG: 15
  GUB cover: 35
  RLT: 1
  Relax-and-lift: 11

Explored 1 nodes (17849 simplex iterations) in 9.30 seconds (13.47 work units)
Thread count was 8 (of 8 available processors)

Solution count 1: 6326.67

Optimal solution found (tolerance 5.00e-04)
Best objective 6.326666666667e+03, best bound 6.326666666667e+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 1153863 rows, 901813 columns and 7829828 nonzeros
Model fingerprint: 0xf3ef7702
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 1148580 rows and 900032 columns
Presolve time: 3.47s
Presolved: 5283 rows, 1781 columns, 14070 nonzeros
Variable types: 4 continuous, 1777 integer (1024 binary)
Found heuristic solution: objective 3689.6666667

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    1.1952000e+04   5.715525e+03   0.000000e+00      6s
    1412    5.4026667e+03   0.000000e+00   0.000000e+00      6s

Root relaxation: objective 5.402667e+03, 1412 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

H    0     0                    5402.6666667 15700.0000   191%     -    5s
     0     0        -    0      5402.66667 5402.66667  0.00%     -    5s

Explored 1 nodes (1853 simplex iterations) in 5.92 seconds (3.27 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 5402.67 3689.67

Optimal solution found (tolerance 1.00e-08)
Best objective 5.402666666667e+03, best bound 5.402666666667e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□5402

 Itr = 2
Collect_LB =   [804.0, 6073.666666666668, 6326.666666666668]
Collect_UB =   [11103.333333333336, 6326.666666666668, 6326.666666666668]
Collect_Hua =   [0.0, 5149.666666666668, 5402.666666666668]
Collect_SPObjVal =   [5149.666666666668, 5402.666666666668, 5402.666666666668]
Collect_MPObjValNHua =   [804.0, 924.0, 924.0]


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

~~~~~~~~~~judge = 2, SPObj_SPF = 5402.666666666668
Vessel i: 0:      pi: 0-6,      ai-di: 3-37,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 3-37,      taoi-deltai: 3-35,      taoPi_SP-deltaPi_SP: 3-35,      betaNi: 32
,      bi: 32
Vessel i: 1:      pi: 6-13,      ai-di: 17-33,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 17-33,      taoi-deltai: 17-31,      taoPi_SP-deltaPi_SP: 17-31,      betaNi
: 14,      bi: 14
Vessel i: 2:      pi: 13-19,      ai-di: 23-49,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 23-49,      taoi-deltai: 23-47,      taoPi_SP-deltaPi_SP: 23-47,
betaNi: 24,      bi: 24
Vessel i: 3:      pi: 7-13,      ai-di: 41-57,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 41-57,      taoi-deltai: 41-55,      taoPi_SP-deltaPi_SP: 41-55,      betaNi
: 14,      bi: 14
Vessel i: 4:      pi: 20-26,      ai-di: 50-74,      gi_SP-gpi_SP: 0.200000-1.000000,      ai_SP-di: 51-74,      taoi-deltai: 51-73,      taoPi_SP-deltaPi_SP: 51-73,
betaNi: 22,      bi: 22
Vessel i: 5:      pi: 12-19,      ai-di: 51-75,      gi_SP-gpi_SP: 1.000000-0.200000,      ai_SP-di: 58-75,      taoi-deltai: 59-81,      taoPi_SP-deltaPi_SP: 59-81,
betaNi: 22,      bi: 22

round LB =   [804, 6074, 6327]
round UB =   [11103, 6327, 6327]
round Hua =   [0, 5150, 5403]
round SPObjVal =   [5150, 5403, 5403]
round MPObjValNHua =   [804, 924, 924]

OptimalObj = 6326.666666666668
Time: 249.000000
```