```
"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=56494

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_TWS.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: 7.55s
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: 0.02s

Solved with dual simplex (primal model)

Root relaxation: objective 7.070000e+02, 2082 iterations, 0.22 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%     -    8s
H    0     0                     707.0000000  707.00000  0.00%     -   11s
     0     0  707.00000    0   30  707.00000  707.00000  0.00%     -   11s

Explored 1 nodes (8613 simplex iterations) in 11.97 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 252651 rows, 9618 columns and 522295 nonzeros
Model fingerprint: 0x9fb855e2
Variable types: 24 continuous, 9594 integer (5544 binary)
Coefficient statistics:
  Matrix range     [1e-01, 1e+10]
  Objective range  [6e-05, 5e+01]
```

```
  Bounds range     [1e+00, 1e+00]
  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 250312 rows and 8754 columns
Presolve time: 0.24s
Presolved: 2339 rows, 864 columns, 6249 nonzeros
Variable types: 4 continuous, 860 integer (499 binary)
Found heuristic solution: objective 2306.6666667
Found heuristic solution: objective 2485.6666667

Root relaxation: objective 4.300667e+03, 733 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

H    0     0                    4300.6666667 9030.00000   110%     -    0s
     0     0          -    0     4300.66667 4300.66667  0.00%     -    0s

Explored 1 nodes (970 simplex iterations) in 0.30 seconds (0.46 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 4300.67 2485.67 2306.67

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 =   [9308.333333333332]
Collect_Hua =   [0.0]
Collect_SPObjVal =   [4300.666666666666]
Collect_MPObjValNHua =   [707.0]


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 422317 rows, 137605 columns and 1149866 nonzeros
Model fingerprint: 0xaa6f2fb8
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 250142 rows and 119726 columns (presolve time = 5s) ...
Presolve removed 399035 rows and 130133 columns
Presolve time: 8.11s
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      8s
    3666    5.0076667e+03   0.000000e+00   0.000000e+00      8s

Root relaxation: objective 5.007667e+03, 3666 iterations, 0.08 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      -     -    8s
H    0     0                    6507.6666667 5007.66667  23.0%     -    9s
H    0     0                    6407.6666667 5007.66667  21.8%     -    9s
     0     0 5007.66667    0  125 6407.66667 5007.66667  21.8%     -    9s
     0     0 5007.66667    0   95 6407.66667 5007.66667  21.8%     -    9s
     0     0 5007.66667    0  169 6407.66667 5007.66667  21.8%     -   10s
     0     0 5007.66667    0  183 6407.66667 5007.66667  21.8%     -   11s
     0     0 5007.66667    0  321 6407.66667 5007.66667  21.8%     -   11s
     0     0 5007.66667    0  256 6407.66667 5007.66667  21.8%     -   11s
     0     0 5007.66667    0  111 6407.66667 5007.66667  21.8%     -   13s
```

```
164       0     0 5007.66667    0   84 6407.66667 5007.66667  21.8%     -   13s
165       0     0 5007.66667    0   49 6407.66667 5007.66667  21.8%     -   14s
166       0     2 5007.66667    0   46 6407.66667 5007.66667  21.8%     -   15s
167      19    20 5007.66667    5  120 6407.66667 5007.66667  21.8%  2667   20s
168      46    34 5007.66667   10  151 6407.66667 5007.66667  21.8%  2445   25s
169     132   128 5007.66667   31  161 6407.66667 5007.66667  21.8%  1699   31s
170  H  202   128                    5887.6666667 5007.66667  14.9%  1386   31s
171     227   207 5007.66667   61  144 5887.66667 5007.66667  14.9%  1363   36s
172     357   468 5007.66667   94  403 5887.66667 5007.66667  14.9%  1195   44s
173     749   852 infeasible  158       5887.66667 5007.66667  14.9%   840   51s
174    1278  1509 5067.66667  326  945 5887.66667 5007.66667  14.9%   610   55s
175  * 1561  1095             309    5207.6666667 5007.66667  3.84%   536   55s
176    2233   635 5027.66667  404   49 5207.66667 5007.66667  3.84%   423   63s
177    2237   638 5007.66667  173  364 5207.66667 5007.66667  3.84%   422   65s
178    2241   640 5127.66667  345  608 5207.66667 5007.66667  3.84%   421   70s
179  H 2241   607                    5127.6666667 5007.66667  2.34%   421   71s
180
181  Cutting planes:
182    Gomory: 38
183    Cover: 475
184    Implied bound: 128
185    Projected implied bound: 163
186    Clique: 230
187    MIR: 93
188    StrongCG: 159
189    Flow cover: 267
190    GUB cover: 33
191    Zero half: 33
192    RLT: 1
193    Relax-and-lift: 128
194    BQP: 3
195
196  Explored 2243 nodes (1036247 simplex iterations) in 74.30 seconds (166.85 work units)
197  Thread count was 8 (of 8 available processors)
198
199  Solution count 5: 5127.67 5207.67 5887.67 ... 6507.67
200
201  Optimal solution found (tolerance 1.00e-10)
202  Best objective 5.127666666667e+03, best bound 5.127666666667e+03, gap 0.0000%
203  Set parameter MIPGap to value 1e-08
204  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
205
206  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
207  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
208
209  Optimize a model with 252651 rows, 9618 columns and 522295 nonzeros
210  Model fingerprint: 0x6e468c1c
211  Variable types: 24 continuous, 9594 integer (5544 binary)
212  Coefficient statistics:
213    Matrix range     [1e-01, 1e+10]
214    Objective range  [6e-05, 5e+01]
215    Bounds range     [1e+00, 1e+00]
216    RHS range        [8e-01, 1e+10]
217  Warning: Model contains large matrix coefficients
218  Warning: Model contains large rhs
219           Consider reformulating model or setting NumericFocus parameter
220           to avoid numerical issues.
221  Presolve removed 247918 rows and 8109 columns
222  Presolve time: 0.20s
223  Presolved: 4733 rows, 1509 columns, 12713 nonzeros
224  Variable types: 4 continuous, 1505 integer (872 binary)
225  Found heuristic solution: objective 3164.6666667
226
227  Root relaxation: objective 4.562667e+03, 1278 iterations, 0.02 seconds (0.02 work units)
228
229      Nodes    |    Current Node    |     Objective Bounds      |     Work
230   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
231
232  H    0     0                    4562.6666667 13320.0000   192%     -    0s
233       0     0          -    0     4562.66667 4562.66667  0.00%     -    0s
234
235  Explored 1 nodes (1939 simplex iterations) in 0.30 seconds (0.48 work units)
236  Thread count was 8 (of 8 available processors)
237
238  Solution count 2: 4562.67 3164.67
239
240  Optimal solution found (tolerance 1.00e-08)
241  Best objective 4.562666666667e+03, best bound 4.562666666667e+03, gap 0.0000%
242  SP is solved
243  SP's optimal solution is'□4562
244
245   Itr = 1
246  Collect_LB =   [707.0, 5127.666666666666]
247  Collect_UB =   [9308.333333333332, 5389.666666666668]
```

```
Collect_Hua =   [0.0, 4300.666666666666]
Collect_SPObjVal =   [4300.666666666666, 4562.666666666668]
Collect_MPObjValNHua =   [707.0, 827.0]


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 422317 rows, 137605 columns and 1149866 nonzeros
Model fingerprint: 0x4faaf56c
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 250142 rows and 119726 columns (presolve time = 5s) ...
Presolve removed 399035 rows and 130133 columns
Presolve time: 8.22s
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    5.2696667e+03   7.540000e+02   0.000000e+00      8s
    3666    5.2696667e+03   0.000000e+00   0.000000e+00      8s

Root relaxation: objective 5.269667e+03, 3666 iterations, 0.08 seconds (0.11 work units)

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

     0     0 5269.66667    0   18          - 5269.66667      -     -    8s
H    0     0                 6769.6666667 5269.66667  22.2%     -    9s
H    0     0                 6669.6666667 5269.66667  21.0%     -    9s
     0     0 5269.66667    0  125 6669.66667 5269.66667  21.0%     -   10s
     0     0 5269.66667    0   95 6669.66667 5269.66667  21.0%     -   10s
     0     0 5269.66667    0  169 6669.66667 5269.66667  21.0%     -   10s
     0     0 5269.66667    0  183 6669.66667 5269.66667  21.0%     -   11s
     0     0 5269.66667    0  321 6669.66667 5269.66667  21.0%     -   12s
     0     0 5269.66667    0  256 6669.66667 5269.66667  21.0%     -   12s
     0     0 5269.66667    0  111 6669.66667 5269.66667  21.0%     -   14s
     0     0 5269.66667    0   84 6669.66667 5269.66667  21.0%     -   14s
     0     0 5269.66667    0   49 6669.66667 5269.66667  21.0%     -   14s
     0     2 5269.66667    0   46 6669.66667 5269.66667  21.0%     -   15s
    19    20 5269.66667    5  120 6669.66667 5269.66667  21.0%  2667   21s
    46    34 5269.66667   10  151 6669.66667 5269.66667  21.0%  2445   25s
   132   128 5269.66667   31  161 6669.66667 5269.66667  21.0%  1699   31s
H  202   128                 6149.6666667 5269.66667  14.3%  1386   31s
   227   207 5269.66667   61  144 6149.66667 5269.66667  14.3%  1363   36s
   357   468 5269.66667   94  403 6149.66667 5269.66667  14.3%  1195   44s
   749   852 infeasible  158      6149.66667 5269.66667  14.3%   840   51s
  1278  1509 5329.66667  326  945 6149.66667 5269.66667  14.3%   610   56s
* 1561  1095             309    5469.6666667 5269.66667  3.66%   536   56s
  2233   635 5289.66667  404   49 5469.66667 5269.66667  3.66%   423   63s
  2237   638 5269.66667  173  364 5469.66667 5269.66667  3.66%   422   65s
  2241   640 5389.66667  345  608 5469.66667 5269.66667  3.66%   421   70s
H 2241   607                 5389.6666667 5269.66667  2.23%   421   71s

Cutting planes:
  Gomory: 38
  Cover: 475
  Implied bound: 128
  Projected implied bound: 163
  Clique: 230
  MIR: 93
  StrongCG: 159
  Flow cover: 267
  GUB cover: 33
  Zero half: 33
  RLT: 1
  Relax-and-lift: 128
  BQP: 3

Explored 2243 nodes (1036247 simplex iterations) in 74.45 seconds (166.85 work units)
Thread count was 8 (of 8 available processors)
```

```
Solution count 5: 5389.67 5469.67 6149.67 ... 6769.67

Optimal solution found (tolerance 1.00e-10)
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]
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Model fingerprint: 0x6e468c1c
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  Matrix range     [1e-01, 1e+10]
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  Bounds range     [1e+00, 1e+00]
  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 247918 rows and 8109 columns
Presolve time: 0.19s
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, 0.02 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                    4562.6666667 13320.0000   192%     -    0s
     0     0          -    0     4562.66667 4562.66667  0.00%     -    0s

Explored 1 nodes (1939 simplex iterations) in 0.28 seconds (0.48 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 = 2
Collect_LB =   [707.0, 5127.666666666666, 5389.666666666668]
Collect_UB =   [9308.333333333332, 5389.666666666668, 5389.666666666668]
Collect_Hua =   [0.0, 4300.666666666666, 4562.666666666668]
Collect_SPObjVal =   [4300.666666666666, 4562.666666666668, 4562.666666666668]
Collect_MPObjValNHua =   [707.0, 827.0, 827.0]


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

~~~~~~~~~~judge = 2, 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, 5390]
round Hua =   [0, 4301, 4563]
round SPObjVal =   [4301, 4563, 4563]
round MPObjValNHua =   [707, 827, 827]

OptimalObj = 5389.666666666668
Time: 204.000000
```