```
"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=15964

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 457807 rows, 40692 columns and 1261015 nonzeros
Model fingerprint: 0x26b91638
Variable types: 1 continuous, 40691 integer (40663 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 249913 rows and 15536 columns (presolve time = 5s) ...
Presolve removed 409264 rows and 27025 columns
Presolve time: 9.88s
Presolved: 48543 rows, 13667 columns, 189280 nonzeros
Variable types: 0 continuous, 13667 integer (13646 binary)

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

Root relaxation presolved: 48542 rows, 13668 columns, 189277 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    9.3400000e+02   1.238750e+02   2.438428e+08     10s
Concurrent spin time: 0.01s

Solved with dual simplex (primal model)

Root relaxation: objective 9.340000e+02, 3187 iterations, 0.46 seconds (0.44 work units)

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

     0     0  934.00000    0   19          -  934.00000      -     -   11s
     0     0  934.00000    0   62          -  934.00000      -     -   11s
     0     0  934.00000    0   67          -  934.00000      -     -   12s
H    0     0                     934.0000000  934.00000  0.00%     -   15s
     0     0  934.00000    0   62  934.00000  934.00000  0.00%     -   15s

Cutting planes:
  Gomory: 7
  Lift-and-project: 1
  Cover: 160
  Implied bound: 494
  Clique: 38
  MIR: 88
  StrongCG: 23
  GUB cover: 26
  Zero half: 3
  RLT: 13
  Relax-and-lift: 19
  PSD: 1

Explored 1 nodes (18522 simplex iterations) in 15.37 seconds (19.11 work units)
Thread count was 8 (of 8 available processors)

Solution count 1: 934

```

```
Optimal solution found (tolerance 1.00e-10)
Best objective 9.340000000000e+02, best bound 9.340000000000e+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 335528 rows, 11221 columns and 691129 nonzeros
Model fingerprint: 0x177da733
Variable types: 28 continuous, 11193 integer (6468 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 331088 rows and 9695 columns
Presolve time: 0.39s
Presolved: 4440 rows, 1526 columns, 11883 nonzeros
Variable types: 6 continuous, 1520 integer (899 binary)
Found heuristic solution: objective 4826.5486169

Root relaxation: objective 6.398549e+03, 1410 iterations, 0.03 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    6398.5486169 6398.54862  0.00%     -    0s

Explored 1 nodes (1842 simplex iterations) in 0.52 seconds (0.66 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 6398.55 4826.55

Optimal solution found (tolerance 1.00e-08)
Best objective 6.398548616906e+03, best bound 6.398548616906e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□6398

 Itr = 0
Collect_LB =   [934.0]
Collect_UB =   [13731.097233811932]
Collect_Hua =   [0.0]
Collect_SPObjVal =   [6398.548616905966]
Collect_MPObjValNHua =   [934.0]


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 462051 rows, 180636 columns and 1265280 nonzeros
Model fingerprint: 0x0d308996
Variable types: 1 continuous, 180635 integer (180607 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 286355 rows and 160742 columns (presolve time = 5s) ...
Presolve removed 438280 rows and 172449 columns
Presolve time: 9.39s
Presolved: 23771 rows, 8187 columns, 100931 nonzeros
Variable types: 0 continuous, 8187 integer (8168 binary)

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    7.3845486e+03   9.987500e+02   0.000000e+00     10s
    3567    7.3845486e+03   0.000000e+00   0.000000e+00     10s

Root relaxation: objective 7.384549e+03, 3567 iterations, 0.08 seconds (0.10 work units)

    Nodes    |    Current Node    |     Objective Bounds      |     Work
```

```
164   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
165
166      0     0 7384.54862    0   25          - 7384.54862      -     -    9s
167      0     0 7384.54862    0   26          - 7384.54862      -     -    9s
168      0     0 7384.54862    0   62          - 7384.54862      -     -   11s
169      0     0 7384.54862    0  132           - 7384.54862      -     -   11s
170      0     0 7384.54862    0  126           - 7384.54862      -     -   11s
171  H   0     0                 8464.5486169 7384.54862  12.8%    -   14s
172      0     0 7384.54862    0  111 8464.54862 7384.54862  12.8%    -   15s
173      0     0 7384.54862    0  110 8464.54862 7384.54862  12.8%    -   15s
174      0     0 7384.54862    0  468 8464.54862 7384.54862  12.8%    -   17s
175      0     0 7384.54862    0  305 8464.54862 7384.54862  12.8%    -   17s
176      0     0 7384.54862    0  269 8464.54862 7384.54862  12.8%    -   18s
177  H   0     0                 7384.5486169 7384.54862  0.00%    -   20s
178      0     0 7384.54862    0   60 7384.54862 7384.54862  0.00%    -   20s
179
180  Cutting planes:
181    Learned: 1
182    Gomory: 3
183    Lift-and-project: 1
184    Cover: 116
185    Implied bound: 662
186    Clique: 1865
187    MIR: 178
188    StrongCG: 140
189    GUB cover: 12
190    Zero half: 13
191    RLT: 11
192    Relax-and-lift: 25
193    BQP: 26
194    PSD: 5
195
196  Explored 1 nodes (50235 simplex iterations) in 20.99 seconds (26.07 work units)
197  Thread count was 8 (of 8 available processors)
198
199  Solution count 2: 7384.55 8464.55
200
201  Optimal solution found (tolerance 1.00e-10)
202  Best objective 7.384548616906e+03, best bound 7.384548616906e+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 335528 rows, 11221 columns and 691129 nonzeros
210  Model fingerprint: 0xebc5c2a5
211  Variable types: 28 continuous, 11193 integer (6468 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 329101 rows and 9093 columns
222  Presolve time: 0.28s
223  Presolved: 6427 rows, 2128 columns, 17197 nonzeros
224  Variable types: 6 continuous, 2122 integer (1228 binary)
225  Found heuristic solution: objective 4691.9988688
226
227  Root relaxation: objective 6.867000e+03, 1863 iterations, 0.03 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      0     0 6867.00000    0   29 4691.99887 6867.00000  46.4%    -    0s
233  H   0     0                 6634.8523388 6867.00000  3.50%    -    0s
234      0     0 6867.00000    0   16 6634.85234 6867.00000  3.50%    -    0s
235      0     0 6867.00000    0   12 6634.85234 6867.00000  3.50%    -    0s
236  H   0     0                 6679.0000000 6867.00000  2.81%    -    0s
237  H   0     0                 6866.9634499 6867.00000  0.00%    -    0s
238      0     0 6867.00000    0    4 6866.96345 6867.00000  0.00%    -    0s
239  H   0     0                 6867.0000000 6867.00000  0.00%    -    0s
240
241  Explored 1 nodes (3305 simplex iterations) in 0.54 seconds (0.71 work units)
242  Thread count was 8 (of 8 available processors)
243
244  Solution count 5: 6867 6866.96 6679 ... 4692
245
246  Optimal solution found (tolerance 1.00e-08)
247  Best objective 6.867000000000e+03, best bound 6.867000000000e+03, gap 0.0000%
```

```
SP is solved
SP's optimal solution is'□6867

 Itr = 1
Collect_LB =   [934.0, 7384.548616905966]
Collect_UB =   [13731.097233811932, 7853.000000000004]
Collect_Hua =   [0.0, 6398.548616905966]
Collect_SPObjVal =   [6398.548616905966, 6867.000000000004]
Collect_MPObjValNHua =   [934.0, 986.0]


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 462051 rows, 180636 columns and 1265280 nonzeros
Model fingerprint: 0xa78d7359
Variable types: 1 continuous, 180635 integer (180607 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 286355 rows and 160742 columns (presolve time = 6s) ...
Presolve removed 286355 rows and 160742 columns (presolve time = 10s) ...
Presolve removed 438280 rows and 172449 columns
Presolve time: 12.38s
Presolved: 23771 rows, 8187 columns, 100931 nonzeros
Variable types: 0 continuous, 8187 integer (8168 binary)

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    7.8530000e+03   9.987500e+02   0.000000e+00     13s
    3567    7.8530000e+03   0.000000e+00   0.000000e+00     13s

Root relaxation: objective 7.853000e+03, 3567 iterations, 0.08 seconds (0.10 work units)

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

     0     0 7853.00000    0   25          - 7853.00000      -     -   12s
     0     0 7853.00000    0   26          - 7853.00000      -     -   12s
     0     0 7853.00000    0   62          - 7853.00000      -     -   14s
     0     0 7853.00000    0  132          - 7853.00000      -     -   14s
     0     0 7853.00000    0  126          - 7853.00000      -     -   14s
H    0     0                 8933.0000000 7853.00000  12.1%     -   18s
     0     0 7853.00000    0  111 8933.00000 7853.00000  12.1%     -   18s
     0     0 7853.00000    0  110 8933.00000 7853.00000  12.1%     -   18s
     0     0 7853.00000    0  468 8933.00000 7853.00000  12.1%     -   20s
     0     0 7853.00000    0  305 8933.00000 7853.00000  12.1%     -   21s
     0     0 7853.00000    0  269 8933.00000 7853.00000  12.1%     -   21s
H    0     0                 7853.0000000 7853.00000  0.00%     -   24s
     0     0 7853.00000    0   60 7853.00000 7853.00000  0.00%     -   24s

Cutting planes:
  Learned: 1
  Gomory: 3
  Lift-and-project: 1
  Cover: 116
  Implied bound: 662
  Clique: 1865
  MIR: 178
  StrongCG: 140
  GUB cover: 12
  Zero half: 13
  RLT: 11
  Relax-and-lift: 25
  BQP: 26
  PSD: 5

Explored 1 nodes (50235 simplex iterations) in 24.39 seconds (26.07 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 7853 8933

Optimal solution found (tolerance 1.00e-10)
Best objective 7.853000000000e+03, best bound 7.853000000000e+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 335528 rows, 11221 columns and 691129 nonzeros
Model fingerprint: 0xebc5c2a5
Variable types: 28 continuous, 11193 integer (6468 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 329101 rows and 9093 columns
Presolve time: 0.27s
Presolved: 6427 rows, 2128 columns, 17197 nonzeros
Variable types: 6 continuous, 2122 integer (1228 binary)
Found heuristic solution: objective 4691.9988688

Root relaxation: objective 6.867000e+03, 1863 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 6867.00000    0   29 4691.99887 6867.00000  46.4%     -    0s
H    0     0                6634.8523388 6867.00000  3.50%     -    0s
     0     0 6867.00000    0   16 6634.85234 6867.00000  3.50%     -    0s
     0     0 6867.00000    0   12 6634.85234 6867.00000  3.50%     -    0s
H    0     0                6679.0000000 6867.00000  2.81%     -    0s
H    0     0                6866.9634499 6867.00000  0.00%     -    0s
     0     0 6867.00000    0    4 6866.96345 6867.00000  0.00%     -    0s
H    0     0                6867.0000000 6867.00000  0.00%     -    0s

Explored 1 nodes (3305 simplex iterations) in 0.52 seconds (0.71 work units)
Thread count was 8 (of 8 available processors)

Solution count 5: 6867 6866.96 6679 ... 4692

Optimal solution found (tolerance 1.00e-08)
Best objective 6.867000000000e+03, best bound 6.867000000000e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□6867

 Itr = 2
Collect_LB =   [934.0, 7384.548616905966, 7853.000000000004]
Collect_UB =   [13731.097233811932, 7853.000000000004, 7853.000000000004]
Collect_Hua =   [0.0, 6398.548616905966, 6867.000000000004]
Collect_SPObjVal =   [6398.548616905966, 6867.000000000004, 6867.000000000004]
Collect_MPObjValNHua =   [934.0, 986.0, 986.0]


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

~~~~~~~~~~judge = 2, SPObj_SPF = 6867.000000000004
Vessel i: 0:     pi: 0-7,     ai-di: 1-33,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 1-33,     taoi-deltai: 1-32,     taoPi_SP-deltaPi_SP: 1-32,     betaNi: 31
,     bi: 31
Vessel i: 1:     pi: 8-13,     ai-di: 5-33,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 5-33,     taoi-deltai: 5-31,     taoPi_SP-deltaPi_SP: 5-31,     betaNi: 26
,     bi: 26
Vessel i: 2:     pi: 13-18,     ai-di: 7-24,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 7-24,     taoi-deltai: 7-22,     taoPi_SP-deltaPi_SP: 7-22,     betaNi: 15
,     bi: 15
Vessel i: 3:     pi: 20-27,     ai-di: 13-50,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 13-50,     taoi-deltai: 13-48,     taoPi_SP-deltaPi_SP: 13-48,
betaNi: 35,     bi: 35
Vessel i: 4:     pi: 13-19,     ai-di: 26-40,     gi_SP-gpi_SP: 0.000000-0.400000,     ai_SP-di: 26-40,     taoi-deltai: 26-38,     taoPi_SP-deltaPi_SP: 26-38,
betaNi: 12,     bi: 12
Vessel i: 5:     pi: 10-15,     ai-di: 32-48,     gi_SP-gpi_SP: 0.800000-0.800000,     ai_SP-di: 38-48,     taoi-deltai: 39-50,     taoPi_SP-deltaPi_SP: 40-50,
betaNi: 11,     bi: 11
Vessel i: 6:     pi: 15-20,     ai-di: 40-78,     gi_SP-gpi_SP: 1.000000-0.600000,     ai_SP-di: 50-78,     taoi-deltai: 50-78,     taoPi_SP-deltaPi_SP: 50-78,
betaNi: 28,     bi: 28

round LB =   [934, 7385, 7853]
round UB =   [13731, 7853, 7853]
round Hua =   [0, 6399, 6867]
round SPObjVal =   [6399, 6867, 6867]
round MPObjValNHua =   [934, 986, 986]

OptimalObj = 7853.000000000004
Time: 119.000000

```

409
410
411