```
"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=40829

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 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: 8.83s
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     10s
Concurrent spin time: 0.02s

Solved with dual simplex (primal model)

Root relaxation: objective 8.430000e+02, 2419 iterations, 0.39 seconds (0.31 work units)
Total elapsed time = 10.24s

     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      -     -   10s
H    0     0                3883.0000000  843.00000  78.3%    -   10s
H    0     0                2023.0000000  843.00000  58.3%    -   11s
     0     0  843.00000    0  148 2023.00000  843.00000  58.3%    -   11s
H    0     0                1963.0000000  843.00000  57.1%    -   12s
     0     0  843.00000    0  148 1963.00000  843.00000  57.1%    -   12s
     0     0  843.00000    0   86 1963.00000  843.00000  57.1%    -   14s
     0     0  843.00000    0   80 1963.00000  843.00000  57.1%    -   14s
H    0     0                1323.0000000  843.00000  36.3%    -   14s
     0     0  843.00000    0   14 1323.00000  843.00000  36.3%    -   17s
     0     0  843.00000    0   19 1323.00000  843.00000  36.3%    -   17s
H    0     0                 883.0000000  843.00000  4.53%    -   17s
     0     0  843.00000    0   87  883.00000  843.00000  4.53%    -   17s
     0     0  843.00000    0   99  883.00000  843.00000  4.53%    -   18s
     0     0  843.00000    0   25  883.00000  843.00000  4.53%    -   23s
     0     0  843.00000    0  211  883.00000  843.00000  4.53%    -   23s
     0     0  843.00000    0  279  883.00000  843.00000  4.53%    -   23s
H    0     0                 843.0000000  843.00000  0.00%    -   24s

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 24.95 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 429995 rows, 12824 columns and 883057 nonzeros
Model fingerprint: 0xe0feb0e0
Variable types: 32 continuous, 12792 integer (7392 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 425042 rows and 11162 columns
Presolve time: 0.36s
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 relaxation: objective 5.605111e+03, 1610 iterations, 0.02 seconds (0.03 work units)

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

     0     0 5605.11111    0   68 3899.11111 5605.11111  43.8%     -    0s
H    0     0                4275.1111111 5605.11111  31.1%     -    0s
H    0     0                5125.1111111 5605.11111  9.37%     -    0s
H    0     0                5145.1111111 5605.11111  8.94%     -    0s
H    0     0                5533.1111111 5605.11111  1.30%     -    0s
H    0     0                5603.6111111 5605.11111  0.03%     -    0s
*    0     0               0    5605.1111111 5605.11111  0.00%     -    0s

Cutting planes:
  Learned: 21
  Gomory: 4
  Cover: 26
  Implied bound: 51
  Clique: 11
  MIR: 5
  StrongCG: 1
  Flow cover: 6
  Network: 7
  RLT: 3
  Relax-and-lift: 17
  PSD: 7

Explored 1 nodes (2414 simplex iterations) in 0.56 seconds (0.83 work units)
Thread count was 8 (of 8 available processors)

Solution count 8: 5605.11 5603.61 5533.11 ... 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]
```

```
164
165
166  Set parameter MIPGap to value 1e-10
167  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
168
169  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
170  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
171
172  Optimize a model with 488880 rows, 229425 columns and 1352246 nonzeros
173  Model fingerprint: 0x46855033
174  Variable types: 1 continuous, 229424 integer (229392 binary)
175  Coefficient statistics:
176    Matrix range     [1e+00, 1e+10]
177    Objective range  [1e+00, 2e+01]
178    Bounds range     [1e+00, 1e+00]
179    RHS range        [1e+00, 2e+10]
180  Warning: Model contains large matrix coefficients
181  Warning: Model contains large rhs
182           Consider reformulating model or setting NumericFocus parameter
183           to avoid numerical issues.
184  Presolve removed 323491 rows and 211253 columns (presolve time = 5s) ...
185  Presolve removed 466034 rows and 221792 columns
186  Presolve time: 8.66s
187  Presolved: 22846 rows, 7633 columns, 95345 nonzeros
188  Variable types: 0 continuous, 7633 integer (7609 binary)
189
190  Root simplex log...
191
192  Iteration    Objective       Primal Inf.    Dual Inf.      Time
193         0    6.4481111e+03   9.100000e+02   0.000000e+00      9s
194      3168    6.4481111e+03   0.000000e+00   0.000000e+00      9s
195
196  Root relaxation: objective 6.448111e+03, 3168 iterations, 0.08 seconds (0.08 work units)
197
198      Nodes    |    Current Node    |     Objective Bounds      |     Work
199   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
200
201       0     0 6448.11111    0   25          - 6448.11111      -     -    9s
202       0     0 6448.11111    0  130          - 6448.11111      -     -   11s
203       0     0 6448.11111    0  127          - 6448.11111      -     -   11s
204       0     0 6448.11111    0  182          - 6448.11111      -     -   11s
205       0     0 6448.11111    0  166          - 6448.11111      -     -   11s
206       0     0 6448.11111    0   37          - 6448.11111      -     -   13s
207       0     0 6448.11111    0   72          - 6448.11111      -     -   13s
208       0     0 6448.11111    0   25          - 6448.11111      -     -   15s
209       0     0 6448.11111    0   48          - 6448.11111      -     -   15s
210       0     0 6448.11111    0  361          - 6448.11111      -     -   15s
211       0     0 6448.11111    0  360          - 6448.11111      -     -   15s
212       0     0 6448.11111    0   50          - 6448.11111      -     -   16s
213       0     0 6448.11111    0   50          - 6448.11111      -     -   16s
214       0     2 6448.11111    0   50          - 6448.11111      -     -   18s
215       7    11 6448.11111    3  571          - 6448.11111      -  2848   20s
216      41    51 6448.11111    9  299          - 6448.11111      -  2269   26s
217      88   117 6448.11111   17  270          - 6448.11111      -  1847   31s
218     169   203 6448.11111   36  217          - 6448.11111      -  1350   35s
219  H  226   203                6448.1111111 6448.11111  0.00%  1101   35s
220
221  Cutting planes:
222    Learned: 4
223    Gomory: 3
224    Cover: 509
225    Implied bound: 991
226    Clique: 958
227    MIR: 186
228    StrongCG: 157
229    GUB cover: 32
230    Zero half: 11
231    RLT: 7
232    Relax-and-lift: 15
233    BQP: 10
234
235  Explored 281 nodes (346551 simplex iterations) in 35.62 seconds (61.74 work units)
236  Thread count was 8 (of 8 available processors)
237
238  Solution count 1: 6448.11
239
240  Optimal solution found (tolerance 1.00e-10)
241  Best objective 6.448111111111e+03, best bound 6.448111111111e+03, gap 0.0000%
242  Set parameter MIPGap to value 1e-08
243  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
244
245  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
246  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
247
```

```
Optimize a model with 429995 rows, 12824 columns and 883057 nonzeros
Model fingerprint: 0x3a694f55
Variable types: 32 continuous, 12792 integer (7392 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 424534 rows and 11016 columns
Presolve time: 0.33s
Presolved: 5461 rows, 1808 columns, 14589 nonzeros
Variable types: 6 continuous, 1802 integer (1046 binary)

Root relaxation: objective 5.783111e+03, 1429 iterations, 0.00 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%     -    0s

Explored 1 nodes (1957 simplex iterations) in 0.47 seconds (0.68 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 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 488880 rows, 229425 columns and 1352246 nonzeros
Model fingerprint: 0x215ab8a4
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 323491 rows and 211253 columns (presolve time = 5s) ...
Presolve removed 466034 rows and 221792 columns
Presolve time: 7.97s
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, 0.08 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      -     -   10s
     0     0 6626.11111    0  166          - 6626.11111      -     -   10s
     0     0 6626.11111    0   37          - 6626.11111      -     -   12s
     0     0 6626.11111    0   72          - 6626.11111      -     -   12s
```

```
     0    0 6626.11111    0   25          - 6626.11111     -    -   13s
     0    0 6626.11111    0   48          - 6626.11111     -    -   13s
     0    0 6626.11111    0  361          - 6626.11111     -    -   14s
     0    0 6626.11111    0  360          - 6626.11111     -    -   14s
     0    0 6626.11111    0   50          - 6626.11111     -    -   15s
     0    0 6626.11111    0   50          - 6626.11111     -    -   15s
     0    2 6626.11111    0   50          - 6626.11111     -    -   17s
    19   22 6626.11111    5  479          - 6626.11111     -  2642   21s
    50   52 6626.11111   11  173          - 6626.11111     -  2247   25s
   120  145 6635.58480   24  246          - 6626.11111     -  1634   31s
   219  279 8466.11111   61  370          - 6626.11111     -  1227   36s
   679  595 6626.11111    8  550          - 6626.11111     -   556   42s
   871  651 6626.11111   17  379          - 6626.11111     -   483   46s
  1068 1017 6626.11111   51  491          - 6626.11111     -   523   54s
  1451 1400 7086.11111  169    3          - 6626.11111     -   455   60s
* 1470  793             186    7086.1111111 6626.11111  6.49%   449   60s
  1954  559 6626.11111   98   50 7086.11111 6626.11111  6.49%   399   69s
  1956  560 6626.11111    4   45 7086.11111 6626.11111  6.49%   398   70s
  1959  562 6766.11111  120  194 7086.11111 6626.11111  6.49%   398   76s
  1961  564 6626.11111   52  316 7086.11111 6626.11111  6.49%   397   81s
H 1962   535                    7026.1111111 6626.11111  5.69%   397   85s
H 1963   509                    6626.1111111 6626.11111  0.00%   397   87s

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 87.31 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 1.00e-10)
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 429995 rows, 12824 columns and 883057 nonzeros
Model fingerprint: 0x77065b1f
Variable types: 32 continuous, 12792 integer (7392 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 424107 rows and 10937 columns
Presolve time: 0.33s
Presolved: 5888 rows, 1887 columns, 15718 nonzeros
Variable types: 6 continuous, 1881 integer (1082 binary)

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%     -    0s
     0     0          -    0     5783.11111 5783.11111  0.00%     -    0s

Explored 1 nodes (2001 simplex iterations) in 0.45 seconds (0.73 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: 208.000000
```