```
"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=55399

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 361160 rows, 34789 columns and 995570 nonzeros
Model fingerprint: 0xd26ac180
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 320138 rows and 23992 columns (presolve time = 5s) ...
Presolve removed 320138 rows and 23992 columns
Presolve time: 5.08s
Presolved: 41022 rows, 10797 columns, 146176 nonzeros
Variable types: 0 continuous, 10797 integer (10782 binary)

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

Root relaxation presolved: 41022 rows, 10797 columns, 146176 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    1.2020000e+03   5.150000e+01   8.888983e+07      6s
Concurrent spin time: 0.02s

Solved with dual simplex (primal model)

Root relaxation: objective 6.820000e+02, 1686 iterations, 0.22 seconds (0.15 work units)

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

     0     0  682.00000    0    8          -  682.00000      -     -    5s
H    0     0                    1622.0000000  682.00000  58.0%     -    6s
     0     0  682.00000    0  133 1622.00000  682.00000  58.0%     -    6s
     0     0  682.00000    0  132 1622.00000  682.00000  58.0%     -    6s
H    0     0                    1202.0000000  682.00000  43.3%     -    6s
H    0     0                     682.0000000  682.00000  0.00%     -    7s

Cutting planes:
  Gomory: 1
  Cover: 23
  Implied bound: 474
  Clique: 1
  MIR: 7
  GUB cover: 4
  RLT: 1
  Relax-and-lift: 4
  BQP: 1

Explored 1 nodes (4505 simplex iterations) in 7.50 seconds (11.33 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 682 1202 1622

Optimal solution found (tolerance 1.00e-10)
Best objective 6.820000000000e+02, best bound 6.820000000000e+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 252657 rows, 9618 columns and 522313 nonzeros
Model fingerprint: 0xb9981503
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 250208 rows and 8721 columns
Presolve time: 0.23s
Presolved: 2449 rows, 897 columns, 6631 nonzeros
Variable types: 0 continuous, 897 integer (507 binary)
Found heuristic solution: objective 3134.6666667
Found heuristic solution: objective 3194.6666667

Root relaxation: objective 4.522667e+03, 799 iterations, 0.00 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                    4522.6666667 9482.66667   110%     -    0s
     0     0          -    0     4522.66667 4522.66667  0.00%     -    0s

Explored 1 nodes (1042 simplex iterations) in 0.31 seconds (0.44 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 4522.67 3194.67 3134.67

Optimal solution found (tolerance 1.00e-08)
Best objective 4.522666666667e+03, best bound 4.522666666667e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□4522

 Itr = 0
Collect_LB =   [682.0]
Collect_UB =   [9727.333333333336]
Collect_Hua =   [0.0]
Collect_SPObjVal =   [4522.666666666668]
Collect_MPObjValNHua =   [682.0]


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 365023 rows, 137605 columns and 999448 nonzeros
Model fingerprint: 0xabd410af
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 252328 rows and 123356 columns (presolve time = 5s) ...
Presolve removed 346305 rows and 131205 columns
Presolve time: 5.53s
Presolved: 18718 rows, 6400 columns, 77369 nonzeros
Variable types: 0 continuous, 6400 integer (6385 binary)

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    5.3246667e+03   6.260000e+02   0.000000e+00      6s
    2249    5.3246667e+03   0.000000e+00   0.000000e+00      6s

Root relaxation: objective 5.324667e+03, 2249 iterations, 0.06 seconds (0.07 work units)

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

```
  Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time

     0     0 5324.66667    0    7         - 5324.66667      -     -    5s
H    0     0                 7024.6666667 5324.66667  24.2%     -    6s
     0     0 5324.66667    0   19 7024.66667 5324.66667  24.2%     -    6s
     0     0 5324.66667    0   24 7024.66667 5324.66667  24.2%     -    6s
     0     0 5324.66667    0   15 7024.66667 5324.66667  24.2%     -    7s
     0     0 5324.66667    0  179 7024.66667 5324.66667  24.2%     -    7s
     0     0 5324.66667    0  150 7024.66667 5324.66667  24.2%     -    7s
     0     0 5324.66667    0  149 7024.66667 5324.66667  24.2%     -    7s
H    0     0                 5324.6666667 5324.66667  0.00%     -    8s
     0     0 5324.66667    0    2 5324.66667 5324.66667  0.00%     -    8s

Cutting planes:
  Lift-and-project: 1
  Cover: 206
  Implied bound: 604
  Clique: 1090
  MIR: 120
  StrongCG: 73
  GUB cover: 16
  Zero half: 19
  RLT: 10
  Relax-and-lift: 24
  BQP: 5

Explored 1 nodes (11392 simplex iterations) in 8.13 seconds (11.27 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 5324.67 7024.67

Optimal solution found (tolerance 1.00e-10)
Best objective 5.324666666667e+03, best bound 5.324666666667e+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 252657 rows, 9618 columns and 522313 nonzeros
Model fingerprint: 0xeb036f9f
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 249896 rows and 8676 columns
Presolve time: 0.23s
Presolved: 2761 rows, 942 columns, 7440 nonzeros
Variable types: 0 continuous, 942 integer (530 binary)

Root relaxation: objective 4.752667e+03, 1042 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                 4752.6666667 9972.66667   110%     -    0s
     0     0        -    0     4752.66667 4752.66667  0.00%     -    0s

Explored 1 nodes (1299 simplex iterations) in 0.33 seconds (0.45 work units)
Thread count was 8 (of 8 available processors)

Solution count 1: 4752.67

Optimal solution found (tolerance 1.00e-08)
Best objective 4.752666666667e+03, best bound 4.752666666667e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□4752

 Itr = 1
Collect_LB =   [682.0, 5324.666666666668]
Collect_UB =   [9727.333333333336, 5554.666666666666]
Collect_Hua =   [0.0, 4522.666666666668]
Collect_SPObjVal =   [4522.666666666668, 4752.666666666666]
Collect_MPObjValNHua =   [682.0, 802.0]


Set parameter MIPGap to value 1e-10
Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
```

```
248
249  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
250  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
251
252  Optimize a model with 365023 rows, 137605 columns and 999448 nonzeros
253  Model fingerprint: 0x87c31eee
254  Variable types: 1 continuous, 137604 integer (137580 binary)
255  Coefficient statistics:
256    Matrix range     [1e+00, 1e+10]
257    Objective range  [1e+00, 2e+01]
258    Bounds range     [1e+00, 1e+00]
259    RHS range        [1e+00, 2e+10]
260  Warning: Model contains large matrix coefficients
261  Warning: Model contains large rhs
262           Consider reformulating model or setting NumericFocus parameter
263           to avoid numerical issues.
264  Presolve removed 306986 rows and 131227 columns (presolve time = 5s) ...
265  Presolve removed 346399 rows and 131231 columns
266  Presolve time: 5.45s
267  Presolved: 18624 rows, 6374 columns, 77004 nonzeros
268  Variable types: 0 continuous, 6374 integer (6359 binary)
269
270  Root simplex log...
271
272  Iteration    Objective       Primal Inf.    Dual Inf.      Time
273         0    5.5946667e+03   6.260000e+02   0.000000e+00      6s
274      2260    5.5946667e+03   0.000000e+00   0.000000e+00      6s
275
276  Root relaxation: objective 5.594667e+03, 2260 iterations, 0.05 seconds (0.06 work units)
277
278       Nodes    |    Current Node    |     Objective Bounds      |     Work
279    Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
280
281       0     0 5594.66667    0    6          - 5594.66667      -     -    5s
282  H    0     0                 7294.6666667 5594.66667  23.3%     -    6s
283       0     0 5594.66667    0  166 7294.66667 5594.66667  23.3%     -    6s
284       0     0 5594.66667    0  124 7294.66667 5594.66667  23.3%     -    6s
285  H    0     0                 6814.6666667 5594.66667  17.9%     -    6s
286       0     0 5594.66667    0  104 6814.66667 5594.66667  17.9%     -    6s
287  H    0     0                 5594.6666667 5594.66667  0.00%     -    7s
288       0     0 5594.66667    0    3 5594.66667 5594.66667  0.00%     -    7s
289
290  Cutting planes:
291    Learned: 1
292    Gomory: 4
293    Cover: 190
294    Implied bound: 401
295    Clique: 261
296    MIR: 112
297    StrongCG: 98
298    GUB cover: 2
299    Zero half: 14
300    RLT: 3
301    Relax-and-lift: 7
302
303  Explored 1 nodes (14662 simplex iterations) in 7.75 seconds (11.06 work units)
304  Thread count was 8 (of 8 available processors)
305
306  Solution count 3: 5594.67 6814.67 7294.67
307
308  Optimal solution found (tolerance 1.00e-10)
309  Best objective 5.594666666667e+03, best bound 5.594666666667e+03, gap 0.0000%
310  Set parameter MIPGap to value 1e-08
311  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
312
313  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
314  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
315
316  Optimize a model with 252657 rows, 9618 columns and 522313 nonzeros
317  Model fingerprint: 0x176d7c54
318  Variable types: 24 continuous, 9594 integer (5544 binary)
319  Coefficient statistics:
320    Matrix range     [1e-01, 1e+10]
321    Objective range  [6e-05, 5e+01]
322    Bounds range     [1e+00, 1e+00]
323    RHS range        [8e-01, 1e+10]
324  Warning: Model contains large matrix coefficients
325  Warning: Model contains large rhs
326           Consider reformulating model or setting NumericFocus parameter
327           to avoid numerical issues.
328  Presolve removed 250097 rows and 8731 columns
329  Presolve time: 0.23s
330  Presolved: 2560 rows, 887 columns, 6934 nonzeros
331  Variable types: 0 continuous, 887 integer (512 binary)
```

```
Root relaxation: objective 4.582667e+03, 831 iterations, 0.00 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                    4582.6666667 9662.66667   111%     -    0s
     0     0        -    0      4582.66667 4582.66667  0.00%     -    0s

Explored 1 nodes (1127 simplex iterations) in 0.31 seconds (0.46 work units)
Thread count was 8 (of 8 available processors)

Solution count 1: 4582.67

Optimal solution found (tolerance 1.00e-08)
Best objective 4.582666666667e+03, best bound 4.582666666667e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□4582

 Itr = 2
Collect_LB =   [682.0, 5324.666666666668, 5594.666666666666]
Collect_UB =   [9727.333333333336, 5554.666666666666, 5424.666666666668]
Collect_Hua =   [0.0, 4522.666666666668, 4752.666666666666]
Collect_SPObjVal =   [4522.666666666668, 4752.666666666666, 4582.666666666668]
Collect_MPObjValNHua =   [682.0, 802.0, 842.0]


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

~~~~~~~~~~judge = 2, SPObj_SPF = 4582.666666666668
Vessel i: 0:      pi: 0-5,      ai-di: 1-37,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 1-37,      taoi-deltai: 1-34,      taoPi_SP-deltaPi_SP: 1-30,      betaNi: 33
,      bi: 33
Vessel i: 1:      pi: 5-11,      ai-di: 10-30,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 10-30,      taoi-deltai: 10-32,      taoPi_SP-deltaPi_SP: 10-32,      betaNi
: 22,      bi: 22
Vessel i: 2:      pi: 16-21,      ai-di: 11-24,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 11-24,      taoi-deltai: 11-27,      taoPi_SP-deltaPi_SP: 11-27,
betaNi: 16,      bi: 16
Vessel i: 3:      pi: 11-16,      ai-di: 13-26,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 13-26,      taoi-deltai: 13-22,      taoPi_SP-deltaPi_SP: 13-22,
betaNi: 9,      bi: 9
Vessel i: 4:      pi: 13-18,      ai-di: 38-63,      gi_SP-gpi_SP: 0.200000-1.000000,      ai_SP-di: 39-63,      taoi-deltai: 39-61,      taoPi_SP-deltaPi_SP: 39-61,
betaNi: 22,      bi: 22
Vessel i: 5:      pi: 8-13,      ai-di: 40-50,      gi_SP-gpi_SP: 1.000000-0.200000,      ai_SP-di: 48-50,      taoi-deltai: 48-58,      taoPi_SP-deltaPi_SP: 48-58,      betaNi
: 10,      bi: 10

round LB =   [682, 5325, 5595]
round UB =   [9727, 5555, 5425]
round Hua =   [0, 4523, 4753]
round SPObjVal =   [4523, 4753, 4583]
round MPObjValNHua =   [682, 802, 842]

OptimalObj = 5594.666666666666
Time: 66.000000
```