```
"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=55694

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 403913 rows, 34789 columns and 1107023 nonzeros
Model fingerprint: 0x0e83549e
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 236665 rows and 14905 columns (presolve time = 5s) ...
Presolve removed 367195 rows and 23817 columns
Presolve time: 6.53s
Presolved: 36718 rows, 10972 columns, 150791 nonzeros
Variable types: 0 continuous, 10972 integer (10954 binary)

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

Root relaxation presolved: 36716 rows, 10974 columns, 150785 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    6.9200000e+02   4.962500e+01   1.100461e+08      7s
Concurrent spin time: 0.02s

Solved with dual simplex (primal model)

Root relaxation: objective 6.920000e+02, 2030 iterations, 0.23 seconds (0.22 work units)

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

     0     0  692.00000    0    4          -  692.00000      -     -    7s
H    0     0                    1272.0000000  692.00000  45.6%     -    7s
H    0     0                     952.0000000  692.00000  27.3%     -    7s
H    0     0                     692.0000000  692.00000  0.00%     -    7s
     0     0  692.00000    0    4  692.00000  692.00000  0.00%     -    7s

Explored 1 nodes (7405 simplex iterations) in 7.57 seconds (12.25 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 692 952 1272

Optimal solution found (tolerance 1.00e-10)
Best objective 6.920000000000e+02, best bound 6.920000000000e+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 252664 rows, 9618 columns and 522334 nonzeros
Model fingerprint: 0x93225a3c
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 250269 rows and 8782 columns
Presolve time: 0.25s
Presolved: 2395 rows, 836 columns, 6371 nonzeros
Variable types: 3 continuous, 833 integer (499 binary)
Found heuristic solution: objective 3476.6666667

Root relaxation: objective 4.538684e+03, 706 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

     0     0 4538.68421    0   65 3476.66667 4538.68421  30.5%     -    0s
H    0     0                4450.6666667 4538.68421  1.98%     -    0s
H    0     0                4470.6666667 4538.68421  1.52%     -    0s
H    0     0                4498.6666667 4528.00000  0.65%     -    0s
     0     0 4528.00000    0    4 4498.66667 4528.00000  0.65%     -    0s
H    0     0                4528.0000000 4528.00000  0.00%     -    0s
     0     0 4528.00000    0    4 4528.00000 4528.00000  0.00%     -    0s

Cutting planes:
  Learned: 3
  Gomory: 7
  Cover: 15
  Implied bound: 14
  Clique: 2
  MIR: 5
  StrongCG: 3
  Flow cover: 4
  Zero half: 1
  RLT: 5
  Relax-and-lift: 2
  PSD: 11

Explored 1 nodes (1151 simplex iterations) in 0.38 seconds (0.46 work units)
Thread count was 8 (of 8 available processors)

Solution count 5: 4528 4498.67 4470.67 ... 3476.67

Optimal solution found (tolerance 1.00e-08)
Best objective 4.528000000000e+03, best bound 4.528000000000e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□4528

 Itr = 0
Collect_LB =   [692.0]
Collect_UB =   [9748.000000000004]
Collect_Hua =   [0.0]
Collect_SPObjVal =   [4528.000000000002]
Collect_MPObjValNHua =   [692.0]


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 407538 rows, 137605 columns and 1110663 nonzeros
Model fingerprint: 0x8adf1037
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 266286 rows and 121758 columns (presolve time = 5s) ...
Presolve removed 383206 rows and 130935 columns
Presolve time: 6.73s
Presolved: 24332 rows, 6670 columns, 89424 nonzeros
Variable types: 0 continuous, 6670 integer (6652 binary)

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
```

```
     0     0    5.2200000e+03   7.340000e+02   0.000000e+00      7s
  2853     0    5.2200000e+03   0.000000e+00   0.000000e+00      7s

Root relaxation: objective 5.220000e+03, 2853 iterations, 0.06 seconds (0.08 work units)

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

     0     0 5220.00000    0    7          - 5220.00000      -     -    7s
     0     0 5220.00000    0   21          - 5220.00000      -     -    7s
     0     0 5220.00000    0   23          - 5220.00000      -     -    7s
     0     0 5220.00000    0    7          - 5220.00000      -     -    8s
     0     0 5220.00000    0   21          - 5220.00000      -     -    9s
     0     0 5220.00000    0   27          - 5220.00000      -     -    9s
H    0     0                 8420.0000000 5220.00000  38.0%     -    9s
     0     0 5220.00000    0   19 8420.00000 5220.00000  38.0%     -    9s
H    0     0                 5980.0000000 5220.00000  12.7%     -   10s
     0     2 5220.00000    0   19 5980.00000 5220.00000  12.7%     -   11s
    53    56 5220.00000   12   77 5980.00000 5220.00000  12.7%   880   15s
*  142   109              59    5620.0000000 5220.00000  7.12%   780   18s
   187   119 5220.00000   29  234 5620.00000 5220.00000  7.12%   717   20s
H  195   119                  5240.0000000 5220.00000  0.38%   711   20s
H  201    33                  5220.0000000 5220.00000  0.00%   695   22s

Cutting planes:
  Learned: 9
  Gomory: 5
  Cover: 4
  Implied bound: 3
  Clique: 27
  MIR: 3
  StrongCG: 4
  Flow cover: 6
  GUB cover: 1
  Zero half: 3
  RLT: 5
  Relax-and-lift: 129

Explored 201 nodes (157916 simplex iterations) in 22.37 seconds (38.85 work units)
Thread count was 8 (of 8 available processors)

Solution count 5: 5220 5240 5620 ... 8420

Optimal solution found (tolerance 1.00e-10)
Best objective 5.220000000000e+03, best bound 5.220000000000e+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 252664 rows, 9618 columns and 522334 nonzeros
Model fingerprint: 0x13bcfa8f
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 249503 rows and 8625 columns
Presolve time: 0.25s
Presolved: 3161 rows, 993 columns, 8390 nonzeros
Variable types: 4 continuous, 989 integer (566 binary)
Found heuristic solution: objective 3825.0731500
Found heuristic solution: objective 3911.3027795

Root relaxation: objective 4.764000e+03, 1027 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 4764.00000    0    9 3911.30278 4764.00000  21.8%     -    0s
H    0     0                 4214.5805573 4764.00000  13.0%     -    0s
H    0     0                 4764.0000000 4764.00000  0.00%     -    0s
     0     0 4764.00000    0    9 4764.00000 4764.00000  0.00%     -    0s

Explored 1 nodes (1527 simplex iterations) in 0.34 seconds (0.52 work units)
Thread count was 8 (of 8 available processors)

Solution count 4: 4764 4214.58 3911.3 3825.07
```

```
248
249  Optimal solution found (tolerance 1.00e-08)
250  Best objective 4.764000000000e+03, best bound 4.764000000000e+03, gap 0.0000%
251  SP is solved
252  SP's optimal solution is'□4764
253
254   Itr = 1
255  Collect_LB =   [692.0, 5220.000000000002]
256  Collect_UB =   [9748.000000000004, 5456.000000000002]
257  Collect_Hua =   [0.0, 4528.000000000002]
258  Collect_SPObjVal =   [4528.000000000002, 4764.000000000002]
259  Collect_MPObjValNHua =   [692.0, 692.0]
260
261
262  Set parameter MIPGap to value 1e-10
263  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
264
265  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
266  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
267
268  Optimize a model with 407538 rows, 137605 columns and 1110663 nonzeros
269  Model fingerprint: 0x24b4d4b2
270  Variable types: 1 continuous, 137604 integer (137580 binary)
271  Coefficient statistics:
272    Matrix range     [1e+00, 1e+10]
273    Objective range  [1e+00, 2e+01]
274    Bounds range     [1e+00, 1e+00]
275    RHS range        [1e+00, 2e+10]
276  Warning: Model contains large matrix coefficients
277  Warning: Model contains large rhs
278           Consider reformulating model or setting NumericFocus parameter
279           to avoid numerical issues.
280  Presolve removed 268336 rows and 121950 columns (presolve time = 5s) ...
281  Presolve removed 383412 rows and 131007 columns
282  Presolve time: 6.70s
283  Presolved: 24126 rows, 6598 columns, 88375 nonzeros
284  Variable types: 0 continuous, 6598 integer (6580 binary)
285
286  Root simplex log...
287
288  Iteration    Objective       Primal Inf.    Dual Inf.      Time
289         0    5.4660000e+03   8.970000e+02   0.000000e+00      7s
290      2930    5.4660000e+03   0.000000e+00   0.000000e+00      7s
291
292  Root relaxation: objective 5.466000e+03, 2930 iterations, 0.06 seconds (0.11 work units)
293
294       Nodes    |    Current Node    |     Objective Bounds      |     Work
295    Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
296
297       0     0 5466.00000    0   14          - 5466.00000      -     -    7s
298       0     0 5466.00000    0   48          - 5466.00000      -     -    7s
299       0     0 5466.00000    0   65          - 5466.00000      -     -    7s
300       0     0 5466.00000    0  126          - 5466.00000      -     -    7s
301       0     0 5466.00000    0  121          - 5466.00000      -     -    7s
302  H    0     0                    5986.0000000 5466.00000  8.69%     -    8s
303       0     0 5466.00000    0   33 5986.00000 5466.00000  8.69%     -    8s
304       0     0 5466.00000    0   47 5986.00000 5466.00000  8.69%     -    8s
305       0     0 5466.00000    0   35 5986.00000 5466.00000  8.69%     -    8s
306       0     0 5466.00000    0   58 5986.00000 5466.00000  8.69%     -    8s
307       0     0 5466.00000    0   55 5986.00000 5466.00000  8.69%     -    9s
308       0     0 5466.00000    0   27 5986.00000 5466.00000  8.69%     -    9s
309       0     0 5466.00000    0   34 5986.00000 5466.00000  8.69%     -    9s
310       0     0 5466.00000    0  140 5986.00000 5466.00000  8.69%     -    9s
311       0     0 5466.00000    0   72 5986.00000 5466.00000  8.69%     -    9s
312       0     0 5466.00000    0   22 5986.00000 5466.00000  8.69%     -   10s
313       0     0 5466.00000    0   98 5986.00000 5466.00000  8.69%     -   10s
314       0     0 5466.00000    0   55 5986.00000 5466.00000  8.69%     -   10s
315       0     0 5466.00000    0   23 5986.00000 5466.00000  8.69%     -   11s
316       0     0 5466.00000    0   33 5986.00000 5466.00000  8.69%     -   11s
317  H    0     0                    5466.0000000 5466.00000  0.00%     -   12s
318       0     0 5466.00000    0   33 5466.00000 5466.00000  0.00%     -   12s
319
320  Cutting planes:
321    Cover: 104
322    Implied bound: 19
323    Clique: 124
324    MIR: 35
325    StrongCG: 29
326    GUB cover: 21
327    RLT: 2
328    Relax-and-lift: 140
329    BQP: 4
330
331  Explored 1 nodes (27552 simplex iterations) in 12.79 seconds (16.97 work units)
```

```
Thread count was 8 (of 8 available processors)

Solution count 2: 5466 5986

Optimal solution found (tolerance 1.00e-10)
Best objective 5.466000000000e+03, best bound 5.466000000000e+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 252664 rows, 9618 columns and 522334 nonzeros
Model fingerprint: 0xbad1b09a
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 248669 rows and 8270 columns
Presolve time: 0.20s
Presolved: 3995 rows, 1348 columns, 10664 nonzeros
Variable types: 4 continuous, 1344 integer (781 binary)
Found heuristic solution: objective 3289.6666667

Root relaxation: objective 4.628667e+03, 1401 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                    4628.6666667 12030.0000   160%     -    0s
     0     0        -    0      4628.66667 4628.66667  0.00%     -    0s

Explored 1 nodes (1682 simplex iterations) in 0.30 seconds (0.44 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 4628.67 3289.67

Optimal solution found (tolerance 1.00e-08)
Best objective 4.628666666667e+03, best bound 4.628666666667e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□4628

 Itr = 2
Collect_LB =   [692.0, 5220.000000000002, 5466.000000000002]
Collect_UB =   [9748.000000000004, 5456.000000000002, 5330.666666666668]
Collect_Hua =   [0.0, 4528.000000000002, 4764.000000000002]
Collect_SPObjVal =   [4528.000000000002, 4764.000000000002, 4628.666666666668]
Collect_MPObjValNHua =   [692.0, 692.0, 702.0]


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

~~~~~~~~~~judge = 2, SPObj_SPF = 4628.666666666668
Vessel i: 0:      pi: 0-5,      ai-di: 3-22,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 3-22,      taoi-deltai: 3-21,      taoPi_SP-deltaPi_SP: 4-16,      betaNi: 18
,      bi: 18
Vessel i: 1:      pi: 5-12,      ai-di: 4-25,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 4-25,      taoi-deltai: 4-24,      taoPi_SP-deltaPi_SP: 4-24,      betaNi: 20
,      bi: 20
Vessel i: 2:      pi: 12-18,      ai-di: 18-26,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 18-26,      taoi-deltai: 18-25,      taoPi_SP-deltaPi_SP: 18-25,
betaNi: 7,      bi: 7
Vessel i: 3:      pi: 6-12,      ai-di: 26-61,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 26-61,      taoi-deltai: 26-60,      taoPi_SP-deltaPi_SP: 26-60,      betaNi
: 34,      bi: 34
Vessel i: 4:      pi: 18-24,      ai-di: 20-68,      gi_SP-gpi_SP: 0.200000-1.000000,      ai_SP-di: 21-68,      taoi-deltai: 24-51,      taoPi_SP-deltaPi_SP: 24-51,
betaNi: 27,      bi: 27
Vessel i: 5:      pi: 12-18,      ai-di: 35-60,      gi_SP-gpi_SP: 1.000000-0.200000,      ai_SP-di: 43-60,      taoi-deltai: 39-48,      taoPi_SP-deltaPi_SP: 43-48,
betaNi: 9,      bi: 9

round LB =   [692, 5220, 5466]
round UB =   [9748, 5456, 5331]
round Hua =   [0, 4528, 4764]
round SPObjVal =   [4528, 4764, 4629]
round MPObjValNHua =   [692, 692, 702]

OptimalObj = 5466.000000000002
Time: 88.000000
```