```
"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=52677

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 394700 rows, 34789 columns and 1080704 nonzeros
Model fingerprint: 0x7c692d28
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 323958 rows and 24242 columns (presolve time = 5s) ...
Presolve removed 358306 rows and 24242 columns
Presolve time: 5.48s
Presolved: 36394 rows, 10547 columns, 140686 nonzeros
Variable types: 0 continuous, 10547 integer (10533 binary)

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

Root relaxation presolved: 36392 rows, 10549 columns, 140680 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    6.3100000e+02   4.900000e+01   1.057647e+08      6s
Concurrent spin time: 0.00s

Solved with dual simplex (primal model)

Root relaxation: objective 6.310000e+02, 1663 iterations, 0.19 seconds (0.18 work units)

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

     0     0  631.00000    0   11          -  631.00000      -     -    6s
     0     0  631.00000    0   56          -  631.00000      -     -    6s
H    0     0                4591.0000000  631.00000  86.3%     -    7s
H    0     0                3271.0000000  631.00000  80.7%     -    7s
     0     0  631.00000    0   56 3271.00000  631.00000  80.7%     -    7s
H    0     0                 631.0000000  631.00000  0.00%     -    9s
     0     0  631.00000    0   42  631.00000  631.00000  0.00%     -    9s

Cutting planes:
  Learned: 4
  Gomory: 5
  Cover: 74
  Implied bound: 1932
  Clique: 14
  MIR: 8
  StrongCG: 5
  GUB cover: 1
  Zero half: 2
  RLT: 6
  Relax-and-lift: 3

Explored 1 nodes (10873 simplex iterations) in 9.05 seconds (13.82 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 631 3271 4591
```

```
Optimal solution found (tolerance 1.00e-10)
Best objective 6.310000000000e+02, best bound 6.310000000000e+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 252684 rows, 9618 columns and 522394 nonzeros
Model fingerprint: 0xeaed5b5e
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 251321 rows and 9134 columns
Presolve time: 0.20s
Presolved: 1363 rows, 484 columns, 3603 nonzeros
Variable types: 0 continuous, 484 integer (286 binary)
Found heuristic solution: objective 3832.5977589
Found heuristic solution: objective 3993.5977589

Root relaxation: objective 4.432598e+03, 410 iterations, 0.00 seconds (0.00 work units)

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

H    0     0                    4432.5977589 6792.59776  53.2%     -    0s
     0     0          -    0     4432.59776 4432.59776  0.00%     -    0s

Explored 1 nodes (539 simplex iterations) in 0.26 seconds (0.41 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 4432.6 3993.6 3832.6

Optimal solution found (tolerance 1.00e-08)
Best objective 4.432597758931e+03, best bound 4.432597758931e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□4432

 Itr = 0
Collect_LB =   [631.0]
Collect_UB =   [9496.195517861626]
Collect_Hua =   [0.0]
Collect_SPObjVal =   [4432.597758930813]
Collect_MPObjValNHua =   [631.0]


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 397645 rows, 137605 columns and 1083664 nonzeros
Model fingerprint: 0xfa54bdf7
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 269985 rows and 121919 columns (presolve time = 5s) ...
Presolve removed 355755 rows and 130625 columns
Presolve time: 6.97s
Presolved: 41890 rows, 6980 columns, 107458 nonzeros
Variable types: 0 continuous, 6980 integer (6966 binary)
Root relaxation presolved: 6980 rows, 48870 columns, 114438 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0     handle free variables                          7s
```

```
     4813    5.0785978e+03   0.000000e+00   0.000000e+00      8s
     4813    5.0785978e+03   0.000000e+00   0.000000e+00      8s

Root relaxation: objective 5.078598e+03, 4813 iterations, 0.48 seconds (0.86 work units)

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

     0     0 5078.59776    0   15          - 5078.59776      -     -    7s
     0     0 5078.59776    0  127          - 5078.59776      -     -    9s
     0     0 5078.59776    0  124          - 5078.59776      -     -    9s
     0     0 5078.59776    0  143          - 5078.59776      -     -    9s
H    0     0                6398.5977589 5078.59776  20.6%     -   10s
H    0     0                6238.5977589 5078.59776  18.6%     -   10s
     0     0 5078.59776    0   31 6238.59776 5078.59776  18.6%     -   11s
     0     0 5078.59776    0   81 6238.59776 5078.59776  18.6%     -   11s
     0     0 5078.59776    0   55 6238.59776 5078.59776  18.6%     -   11s
     0     0 5078.59776    0  123 6238.59776 5078.59776  18.6%     -   11s
     0     0 5078.59776    0  104 6238.59776 5078.59776  18.6%     -   11s
     0     0 5078.59776    0   38 6238.59776 5078.59776  18.6%     -   13s
     0     0 5078.59776    0   28 6238.59776 5078.59776  18.6%     -   13s
     0     0 5078.59776    0   20 6238.59776 5078.59776  18.6%     -   13s
     0     0 5078.59776    0   53 6238.59776 5078.59776  18.6%     -   13s
     0     0 5078.59776    0   29 6238.59776 5078.59776  18.6%     -   14s
     0     0 5078.59776    0   16 6238.59776 5078.59776  18.6%     -   14s
H    0     0                5718.5977589 5078.59776  11.2%     -   14s
H    0     0                5078.5977589 5078.59776  0.00%     -   15s
     0     0 5078.59776    0   16 5078.59776 5078.59776  0.00%     -   15s

Cutting planes:
  Learned: 1
  Gomory: 2
  Cover: 133
  Implied bound: 77
  Clique: 238
  MIR: 46
  StrongCG: 28
  GUB cover: 4
  Zero half: 4
  RLT: 1
  Relax-and-lift: 30
  BQP: 5

Explored 1 nodes (36641 simplex iterations) in 15.91 seconds (21.05 work units)
Thread count was 8 (of 8 available processors)

Solution count 4: 5078.6 5718.6 6238.6 6398.6

Optimal solution found (tolerance 1.00e-10)
Best objective 5.078597758931e+03, best bound 5.078597758931e+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 252684 rows, 9618 columns and 522394 nonzeros
Model fingerprint: 0xddb46b5f
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 248284 rows and 8131 columns
Presolve time: 0.19s
Presolved: 4400 rows, 1487 columns, 11629 nonzeros
Variable types: 4 continuous, 1483 integer (866 binary)
Found heuristic solution: objective 3396.6666667
Found heuristic solution: objective 3488.6666667

Root relaxation: objective 4.946667e+03, 1282 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

*    0     0               0    4946.6666667 4946.66667  0.00%     -    0s

Explored 1 nodes (1732 simplex iterations) in 0.30 seconds (0.44 work units)
Thread count was 8 (of 8 available processors)
```

```
248
249  Solution count 3: 4946.67 3488.67 3396.67
250
251  Optimal solution found (tolerance 1.00e-08)
252  Best objective 4.946666666667e+03, best bound 4.946666666667e+03, gap 0.0000%
253  SP is solved
254  SP's optimal solution is'□4946
255
256   Itr = 1
257  Collect_LB =   [631.0, 5078.597758930813]
258  Collect_UB =   [9496.195517861626, 5592.666666666666]
259  Collect_Hua =   [0.0, 4432.597758930813]
260  Collect_SPObjVal =   [4432.597758930813, 4946.666666666666]
261  Collect_MPObjValNHua =   [631.0, 646.0]
262
263
264  Set parameter MIPGap to value 1e-10
265  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
266
267  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
268  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
269
270  Optimize a model with 397645 rows, 137605 columns and 1083664 nonzeros
271  Model fingerprint: 0x26f8e3da
272  Variable types: 1 continuous, 137604 integer (137580 binary)
273  Coefficient statistics:
274    Matrix range     [1e+00, 1e+10]
275    Objective range  [1e+00, 2e+01]
276    Bounds range     [1e+00, 1e+00]
277    RHS range        [1e+00, 2e+10]
278  Warning: Model contains large matrix coefficients
279  Warning: Model contains large rhs
280           Consider reformulating model or setting NumericFocus parameter
281           to avoid numerical issues.
282  Presolve removed 270382 rows and 121964 columns (presolve time = 5s) ...
283  Presolve removed 355749 rows and 130623 columns
284  Presolve time: 6.53s
285  Presolved: 41896 rows, 6982 columns, 107478 nonzeros
286  Variable types: 0 continuous, 6982 integer (6968 binary)
287  Root relaxation presolved: 6982 rows, 48878 columns, 114460 nonzeros
288
289
290  Root simplex log...
291
292  Iteration    Objective       Primal Inf.    Dual Inf.      Time
293         0     handle free variables                        7s
294      4705    5.5776667e+03   0.000000e+00   0.000000e+00      7s
295      4705    5.5776667e+03   0.000000e+00   0.000000e+00      7s
296
297  Root relaxation: objective 5.577667e+03, 4705 iterations, 0.45 seconds (0.77 work units)
298
299      Nodes    |    Current Node    |     Objective Bounds      |     Work
300   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
301
302       0     0 5577.66667    0   14          - 5577.66667      -     -    7s
303  H    0     0                 7777.6666667 5577.66667  28.3%     -    7s
304       0     0 5577.66667    0   92 7777.66667 5577.66667  28.3%     -    8s
305       0     0 5577.66667    0   92 7777.66667 5577.66667  28.3%     -    8s
306       0     0 5577.66667    0   90 7777.66667 5577.66667  28.3%     -    8s
307  H    0     0                 7737.6666667 5577.66667  27.9%     -   10s
308       0     0 5577.66667    0   51 7737.66667 5577.66667  27.9%     -   10s
309       0     0 5577.66667    0   49 7737.66667 5577.66667  27.9%     -   10s
310  H    0     0                 6377.6666667 5577.66667  12.5%     -   10s
311  H    0     0                 6217.6666667 5577.66667  10.3%     -   10s
312  H    0     0                 5817.6666667 5577.66667  4.13%     -   10s
313       0     0 5577.66667    0  124 5817.66667 5577.66667  4.13%     -   10s
314       0     0 5577.66667    0  120 5817.66667 5577.66667  4.13%     -   10s
315       0     0 5577.66667    0  172 5817.66667 5577.66667  4.13%     -   11s
316       0     0 5577.66667    0   12 5817.66667 5577.66667  4.13%     -   12s
317  H    0     0                 5577.6666667 5577.66667  0.00%     -   12s
318       0     0 5577.66667    0  137 5577.66667 5577.66667  0.00%     -   12s
319
320  Cutting planes:
321    Learned: 4
322    Gomory: 2
323    Cover: 5
324    Implied bound: 690
325    Clique: 12
326    MIR: 7
327    StrongCG: 5
328    GUB cover: 6
329    RLT: 2
330    Relax-and-lift: 5
331
```

```
Explored 1 nodes (26603 simplex iterations) in 12.54 seconds (17.25 work units)
Thread count was 8 (of 8 available processors)

Solution count 6: 5577.67 5817.67 6217.67 ... 7777.67

Optimal solution found (tolerance 1.00e-10)
Best objective 5.577666666667e+03, best bound 5.577666666667e+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 252684 rows, 9618 columns and 522394 nonzeros
Model fingerprint: 0x7399ca50
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 251336 rows and 9160 columns
Presolve time: 0.36s
Presolved: 1348 rows, 458 columns, 3597 nonzeros
Variable types: 0 continuous, 458 integer (263 binary)
Found heuristic solution: objective 4408.6666667
Found heuristic solution: objective 4502.6666667

Root relaxation: objective 4.872667e+03, 322 iterations, 0.00 seconds (0.00 work units)

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

H    0     0                    4872.6666667 7850.66667  61.1%     -    0s
     0     0        -    0      4872.66667 4872.66667  0.00%     -    0s

Explored 1 nodes (421 simplex iterations) in 0.44 seconds (0.57 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 4872.67 4502.67 4408.67

Optimal solution found (tolerance 1.00e-08)
Best objective 4.872666666667e+03, best bound 4.872666666667e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□4872

 Itr = 2
Collect_LB =   [631.0, 5078.597758930813, 5577.666666666666]
Collect_UB =   [9496.195517861626, 5592.666666666666, 5503.666666666666]
Collect_Hua =   [0.0, 4432.597758930813, 4946.666666666666]
Collect_SPObjVal =   [4432.597758930813, 4946.666666666666, 4872.666666666666]
Collect_MPObjValNHua =   [631.0, 646.0, 631.0]


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

~~~~~~~~~~judge = 2, SPObj_SPF = 4872.666666666666
Vessel i: 0:     pi: 0-5,     ai-di: 2-11,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 2-11,     taoi-deltai: 2-11,     taoPi_SP-deltaPi_SP: 2-11,     betaNi: 9,     bi: 9
Vessel i: 1:     pi: 5-11,     ai-di: 7-27,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 7-27,     taoi-deltai: 7-27,     taoPi_SP-deltaPi_SP: 22-27,     betaNi: 20,     bi: 20
Vessel i: 2:     pi: 11-18,     ai-di: 2-15,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 2-15,     taoi-deltai: 2-15,     taoPi_SP-deltaPi_SP: 2-15,     betaNi: 13,     bi: 13
Vessel i: 3:     pi: 16-20,     ai-di: 22-50,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 22-50,     taoi-deltai: 22-50,     taoPi_SP-deltaPi_SP: 22-50,     betaNi: 28,     bi: 28
Vessel i: 4:     pi: 20-25,     ai-di: 23-62,     gi_SP-gpi_SP: 0.200000-1.000000,     ai_SP-di: 24-62,     taoi-deltai: 24-43,     taoPi_SP-deltaPi_SP: 24-43,     betaNi: 19,     bi: 19
Vessel i: 5:     pi: 10-16,     ai-di: 30-70,     gi_SP-gpi_SP: 1.000000-0.200000,     ai_SP-di: 38-70,     taoi-deltai: 38-66,     taoPi_SP-deltaPi_SP: 38-66,     betaNi: 28,     bi: 28

round LB =   [631, 5079, 5578]
round UB =   [9496, 5593, 5504]
round Hua =   [0, 4433, 4947]
round SPObjVal =   [4433, 4947, 4873]
round MPObjValNHua =   [631, 646, 631]

OptimalObj = 5577.666666666666
Time: 82.000000

```

410
411
412