```
"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=52746

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 375969 rows, 34789 columns and 1042007 nonzeros
Model fingerprint: 0x36dd4b10
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 326897 rows and 23704 columns
Presolve time: 4.77s
Presolved: 49072 rows, 11085 columns, 174856 nonzeros
Variable types: 0 continuous, 11085 integer (11070 binary)

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

Root relaxation presolved: 49072 rows, 11085 columns, 174856 nonzeros

Concurrent spin time: 0.02s

Solved with dual simplex (primal model)

Root relaxation: objective 6.660000e+02, 1309 iterations, 0.17 seconds (0.16 work units)

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

     0     0  666.00000    0    3          -  666.00000      -     -    5s
H    0     0                1106.0000000  666.00000  39.8%     -    5s
H    0     0                 666.0000000  666.00000  0.00%     -    5s

Cutting planes:
  Gomory: 1
  Cover: 1
  StrongCG: 1
  GUB cover: 1
  RLT: 2

Explored 1 nodes (2694 simplex iterations) in 5.73 seconds (10.09 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 666 1106

Optimal solution found (tolerance 1.00e-10)
Best objective 6.660000000000e+02, best bound 6.660000000000e+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 252589 rows, 9618 columns and 522109 nonzeros
Model fingerprint: 0xc369ab6c
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 251162 rows and 9135 columns
Presolve time: 0.22s
Presolved: 1427 rows, 483 columns, 3802 nonzeros
Variable types: 0 continuous, 483 integer (274 binary)
Found heuristic solution: objective 2803.6666667

Root relaxation: objective 3.220667e+03, 293 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                    3220.6666667 6180.66667  91.9%     -    0s
     0     0        -    0      3220.66667 3220.66667  0.00%     -    0s

Explored 1 nodes (445 simplex iterations) in 0.31 seconds (0.42 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 3220.67 2803.67

Optimal solution found (tolerance 1.00e-08)
Best objective 3.220666666667e+03, best bound 3.220666666667e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□3220

 Itr = 0
Collect_LB =   [666.0]
Collect_UB =   [7107.333333333336]
Collect_Hua =   [0.0]
Collect_SPObjVal =   [3220.666666666668]
Collect_MPObjValNHua =   [666.0]


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 382144 rows, 137605 columns and 1048197 nonzeros
Model fingerprint: 0x4d868613
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 355840 rows and 133024 columns
Presolve time: 4.28s
Presolved: 26304 rows, 4581 columns, 69310 nonzeros
Variable types: 0 continuous, 4581 integer (4566 binary)
Root relaxation presolved: 4581 rows, 30885 columns, 73891 nonzeros


Root relaxation: objective 4.066667e+03, 3466 iterations, 0.23 seconds (0.33 work units)

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

     0     0 4066.66667    0    7          - 4066.66667      -     -    4s
     0     0 4066.66667    0  169          - 4066.66667      -     -    5s
     0     0 4066.66667    0  162          - 4066.66667      -     -    5s
H    0     0                    4146.6666667 4066.66667  1.93%     -    5s
     0     0 4066.66667    0   99 4146.66667 4066.66667  1.93%     -    5s
     0     0 4066.66667    0  102 4146.66667 4066.66667  1.93%     -    5s
     0     0 4066.66667    0   63 4146.66667 4066.66667  1.93%     -    5s
H    0     0                    4066.6666667 4066.66667  0.00%     -    5s

Cutting planes:
  Cover: 105
  Implied bound: 660
  Clique: 25
  MIR: 8
  StrongCG: 2
  GUB cover: 6
  Zero half: 3
```

```
  RLT: 1
  Relax-and-lift: 49

Explored 1 nodes (7800 simplex iterations) in 5.86 seconds (9.60 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 4066.67 4146.67

Optimal solution found (tolerance 1.00e-10)
Best objective 4.066666666667e+03, best bound 4.066666666667e+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 252589 rows, 9618 columns and 522109 nonzeros
Model fingerprint: 0x78b57276
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 251008 rows and 9039 columns
Presolve time: 0.19s
Presolved: 1581 rows, 579 columns, 4212 nonzeros
Variable types: 4 continuous, 575 integer (337 binary)
Found heuristic solution: objective 2624.3818887

Root relaxation: objective 3.444667e+03, 417 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                    3444.6666667 6522.00000  89.3%     -    0s
     0     0          -    0     3444.66667 3444.66667  0.00%     -    0s

Explored 1 nodes (569 simplex iterations) in 0.27 seconds (0.36 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 3444.67 2624.38

Optimal solution found (tolerance 1.00e-08)
Best objective 3.444666666667e+03, best bound 3.444666666667e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□3444

 Itr = 1
Collect_LB =   [666.0, 4066.666666666668]
Collect_UB =   [7107.333333333336, 4290.666666666668]
Collect_Hua =   [0.0, 3220.666666666668]
Collect_SPObjVal =   [3220.666666666668, 3444.666666666668]
Collect_MPObjValNHua =   [666.0, 846.0]


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 382144 rows, 137605 columns and 1048197 nonzeros
Model fingerprint: 0xcf2e1b6c
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 355840 rows and 133024 columns
Presolve time: 4.39s
Presolved: 26304 rows, 4581 columns, 69310 nonzeros
Variable types: 0 continuous, 4581 integer (4566 binary)
Root relaxation presolved: 4581 rows, 30885 columns, 73891 nonzeros

```

```
248
249  Root relaxation: objective 4.290667e+03, 3466 iterations, 0.19 seconds (0.33 work units)
250
251      Nodes    |    Current Node    |     Objective Bounds      |     Work
252   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
253
254      0     0 4290.66667    0    7          - 4290.66667      -     -    4s
255      0     0 4290.66667    0  169          - 4290.66667      -     -    5s
256      0     0 4290.66667    0  162          - 4290.66667      -     -    5s
257  H    0     0                    4370.6666667 4290.66667  1.83%     -    5s
258      0     0 4290.66667    0   99 4370.66667 4290.66667  1.83%     -    5s
259      0     0 4290.66667    0  102 4370.66667 4290.66667  1.83%     -    5s
260      0     0 4290.66667    0   63 4370.66667 4290.66667  1.83%     -    5s
261  H    0     0                    4290.6666667 4290.66667  0.00%     -    5s
262
263  Cutting planes:
264    Cover: 105
265    Implied bound: 660
266    Clique: 25
267    MIR: 8
268    StrongCG: 2
269    GUB cover: 6
270    Zero half: 3
271    RLT: 1
272    Relax-and-lift: 49
273
274  Explored 1 nodes (7800 simplex iterations) in 5.84 seconds (9.60 work units)
275  Thread count was 8 (of 8 available processors)
276
277  Solution count 2: 4290.67 4370.67
278
279  Optimal solution found (tolerance 1.00e-10)
280  Best objective 4.290666666667e+03, best bound 4.290666666667e+03, gap 0.0000%
281  Set parameter MIPGap to value 1e-08
282  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
283
284  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
285  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
286
287  Optimize a model with 252589 rows, 9618 columns and 522109 nonzeros
288  Model fingerprint: 0x78b57276
289  Variable types: 24 continuous, 9594 integer (5544 binary)
290  Coefficient statistics:
291    Matrix range     [1e-01, 1e+10]
292    Objective range  [6e-05, 5e+01]
293    Bounds range     [1e+00, 1e+00]
294    RHS range        [8e-01, 1e+10]
295  Warning: Model contains large matrix coefficients
296  Warning: Model contains large rhs
297           Consider reformulating model or setting NumericFocus parameter
298           to avoid numerical issues.
299  Presolve removed 251008 rows and 9039 columns
300  Presolve time: 0.19s
301  Presolved: 1581 rows, 579 columns, 4212 nonzeros
302  Variable types: 4 continuous, 575 integer (337 binary)
303  Found heuristic solution: objective 2624.3818887
304
305  Root relaxation: objective 3.444667e+03, 417 iterations, 0.02 seconds (0.00 work units)
306
307      Nodes    |    Current Node    |     Objective Bounds      |     Work
308   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
309
310  H    0     0                    3444.6666667 6522.00000  89.3%     -    0s
311       0     0          -    0     3444.66667 3444.66667  0.00%     -    0s
312
313  Explored 1 nodes (569 simplex iterations) in 0.28 seconds (0.36 work units)
314  Thread count was 8 (of 8 available processors)
315
316  Solution count 2: 3444.67 2624.38
317
318  Optimal solution found (tolerance 1.00e-08)
319  Best objective 3.444666666667e+03, best bound 3.444666666667e+03, gap 0.0000%
320  SP is solved
321  SP's optimal solution is'□3444
322
323   Itr = 2
324  Collect_LB =   [666.0, 4066.666666666668, 4290.666666666668]
325  Collect_UB =   [7107.333333333336, 4290.666666666668, 4290.666666666668]
326  Collect_Hua =   [0.0, 3220.666666666668, 3444.666666666668]
327  Collect_SPObjVal =   [3220.666666666668, 3444.666666666668, 3444.666666666668]
328  Collect_MPObjValNHua =   [666.0, 846.0, 846.0]
329
330
331    Reach the termination conditions, stop iteration
```

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

~~~~~~~~~~judge = 2, SPObj_SPF = 3444.666666666668
Vessel i: 0:    pi: 0-6,    ai-di: 2-23,    gi_SP-gpi_SP: 0.000000-0.000000,    ai_SP-di: 2-23,    taoi-deltai: 2-25,    taoPi_SP-deltaPi_SP: 2-21,    betaNi: 23,    bi: 23
Vessel i: 1:    pi: 6-13,    ai-di: 8-17,    gi_SP-gpi_SP: 0.000000-0.000000,    ai_SP-di: 8-17,    taoi-deltai: 8-16,    taoPi_SP-deltaPi_SP: 8-16,    betaNi: 8,    bi: 8
Vessel i: 2:    pi: 3-10,    ai-di: 34-42,    gi_SP-gpi_SP: 0.000000-0.000000,    ai_SP-di: 34-42,    taoi-deltai: 34-41,    taoPi_SP-deltaPi_SP: 34-39,    betaNi: 7,    bi: 7
Vessel i: 3:    pi: 12-19,    ai-di: 40-58,    gi_SP-gpi_SP: 0.000000-0.000000,    ai_SP-di: 40-58,    taoi-deltai: 40-56,    taoPi_SP-deltaPi_SP: 40-56,    betaNi: 16,    bi: 16
Vessel i: 4:    pi: 6-12,    ai-di: 47-59,    gi_SP-gpi_SP: 0.200000-1.000000,    ai_SP-di: 48-59,    taoi-deltai: 48-61,    taoPi_SP-deltaPi_SP: 48-61,    betaNi: 13,    bi: 13
Vessel i: 5:    pi: 27-34,    ai-di: 50-67,    gi_SP-gpi_SP: 1.000000-0.200000,    ai_SP-di: 58-67,    taoi-deltai: 58-77,    taoPi_SP-deltaPi_SP: 58-77,    betaNi: 19,    bi: 19

round LB =  [666, 4067, 4291]
round UB =  [7107, 4291, 4291]
round Hua =  [0, 3221, 3445]
round SPObjVal =  [3221, 3445, 3445]
round MPObjValNHua =  [666, 846, 846]

OptimalObj = 4290.666666666668
Time: 63.000000
```