```
"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=1357

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_BDC.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 = 5s) ...
Presolve removed 326897 rows and 23704 columns
Presolve time: 5.14s
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: 0.01s

Solved with dual simplex (primal model)

Root relaxation: objective 6.660000e+02, 1309 iterations, 0.20 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%     -    6s
H    0     0                 666.0000000  666.00000  0.00%     -    6s

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

Explored 1 nodes (2694 simplex iterations) in 6.34 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 1153867 rows, 901813 columns and 7829844 nonzeros
Model fingerprint: 0xc590e27d
Variable types: 441325 continuous, 460488 integer (456438 binary)
Coefficient statistics:
  Matrix range     [1e-01, 1e+10]
  Objective range  [6e-05, 5e+01]
```

```
  Bounds range     [1e+00, 8e+01]
  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 1152440 rows and 901330 columns
Presolve time: 2.64s
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, 0.01 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%     -    3s
     0     0         -    0     3220.66667 3220.66667  0.00%     -    3s

Explored 1 nodes (445 simplex iterations) in 3.48 seconds (3.65 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 =   [7107.3333333333285]
Collect_Hua =   [0.0]
Collect_SPObjVal =   [3220.6666666666642]
Collect_MPObjValNHua =   [666.0]


Set parameter TimeLimit to value 12000
Set parameter MIPGap to value 0.0005
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 382145 rows, 137605 columns and 1048210 nonzeros
Model fingerprint: 0xbadabcd3
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 355841 rows and 133024 columns
Presolve time: 4.51s
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, 0.21 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      -     -    5s
     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%     -    6s

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 6.14 seconds (9.60 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 4066.67 4146.67

Optimal solution found (tolerance 5.00e-04)
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 1153867 rows, 901813 columns and 7829844 nonzeros
Model fingerprint: 0x1926e721
Variable types: 441325 continuous, 460488 integer (456438 binary)
Coefficient statistics:
  Matrix range     [1e-01, 1e+10]
  Objective range  [6e-05, 5e+01]
  Bounds range     [1e+00, 8e+01]
  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 1152286 rows and 901234 columns
Presolve time: 2.36s
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%     -    3s
     0     0        -    0      3444.66667 3444.66667  0.00%     -    3s

Explored 1 nodes (569 simplex iterations) in 3.14 seconds (3.18 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, 4066.6666666666642]
Collect_UB =   [7107.3333333333285, 4290.666666666664]
Collect_Hua =   [0.0, 3220.6666666666642]
Collect_SPObjVal =   [3220.6666666666642, 3444.6666666666642]
Collect_MPObjValNHua =   [666.0, 846.0]


Set parameter TimeLimit to value 12000
Set parameter MIPGap to value 0.0005
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 382146 rows, 137605 columns and 1048223 nonzeros
Model fingerprint: 0x66aa3021
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 355842 rows and 133024 columns
Presolve time: 4.48s
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 4.290667e+03, 3466 iterations, 0.21 seconds (0.33 work units)

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

     0     0 4290.66667    0    7          - 4290.66667      -     -    4s
     0     0 4290.66667    0  169          - 4290.66667      -     -    5s
     0     0 4290.66667    0  162          - 4290.66667      -     -    5s
H    0     0                4370.6666667 4290.66667  1.83%     -    5s
     0     0 4290.66667    0   99 4370.66667 4290.66667  1.83%     -    5s
     0     0 4290.66667    0  102 4370.66667 4290.66667  1.83%     -    5s
     0     0 4290.66667    0   63 4370.66667 4290.66667  1.83%     -    5s
H    0     0                4290.6666667 4290.66667  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 5.98 seconds (9.60 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 4290.67 4370.67

Optimal solution found (tolerance 5.00e-04)
Best objective 4.290666666667e+03, best bound 4.290666666667e+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 1153867 rows, 901813 columns and 7829844 nonzeros
Model fingerprint: 0x1926e721
Variable types: 441325 continuous, 460488 integer (456438 binary)
Coefficient statistics:
  Matrix range     [1e-01, 1e+10]
  Objective range  [6e-05, 5e+01]
  Bounds range     [1e+00, 8e+01]
  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 1152286 rows and 901234 columns
Presolve time: 2.33s
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%     -    2s
     0     0        -    0     3444.66667 3444.66667  0.00%     -    2s

Explored 1 nodes (569 simplex iterations) in 3.12 seconds (3.18 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 = 2
Collect_LB =   [666.0, 4066.6666666666642, 4290.666666666664]
Collect_UB =   [7107.3333333333285, 4290.666666666664, 4290.666666666664]
Collect_Hua =   [0.0, 3220.6666666666642, 3444.6666666666642]
Collect_SPObjVal =   [3220.6666666666642, 3444.6666666666642, 3444.6666666666642]
Collect_MPObjValNHua =   [666.0, 846.0, 846.0]
```

```
332
333
334   Reach the termination conditions, stop iteration
335   Values adopted from the Itr' th iteration, and Itr = {2}, judgeCount = {2}
336
337   ~~~~~~~~~~judge = 2, SPObj_SPF = 3444.6666666666642
338   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
339   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
340   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
341   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
342   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
343   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
344
345   round LB =   [666, 4067, 4291]
346   round UB =   [7107, 4291, 4291]
347   round Hua =   [0, 3221, 3445]
348   round SPObjVal =   [3221, 3445, 3445]
349   round MPObjValNHua =   [666, 846, 846]
350
351   OptimalObj = 4290.666666666664
352   Time: 248.000000
353
354
355
356
```