```
"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=40883

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 532644 rows, 52642 columns and 1496394 nonzeros
Model fingerprint: 0xc3512c76
Variable types: 1 continuous, 52641 integer (52605 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 302841 rows and 23943 columns (presolve time = 5s) ...
Presolve removed 460984 rows and 34620 columns
Presolve time: 9.90s
Presolved: 71660 rows, 18022 columns, 271487 nonzeros
Variable types: 0 continuous, 18022 integer (17995 binary)

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

Root relaxation presolved: 18022 rows, 89682 columns, 289509 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    8.9300000e+02   0.000000e+00   1.119000e+03     11s
Concurrent spin time: 0.00s

Solved with dual simplex (primal model)

Root relaxation: objective 8.930000e+02, 2440 iterations, 0.42 seconds (0.33 work units)

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

     0     0  893.00000    0   12          -  893.00000      -     -   11s
H    0     0                5293.0000000  893.00000  83.1%     -   12s
H    0     0                4973.0000000  893.00000  82.0%     -   12s
H    0     0                3853.0000000  893.00000  76.8%     -   12s
     0     0  893.00000    0  168 3853.00000  893.00000  76.8%     -   13s
H    0     0                2133.0000000  893.00000  58.1%     -   13s
H    0     0                2013.0000000  893.00000  55.6%     -   13s
     0     0  893.00000    0  167 2013.00000  893.00000  55.6%     -   13s
     0     0  893.00000    0   54 2013.00000  893.00000  55.6%     -   15s
     0     0  893.00000    0   64 2013.00000  893.00000  55.6%     -   16s
H    0     0                 893.0000000  893.00000  0.00%     -   17s
     0     0  893.00000    0   12  893.00000  893.00000  0.00%     -   17s

Cutting planes:
  Cover: 37
  Implied bound: 875
  Clique: 8
  MIR: 51
  StrongCG: 47
  GUB cover: 4
  RLT: 7
  Relax-and-lift: 472

Explored 1 nodes (17191 simplex iterations) in 17.69 seconds (22.99 work units)
Thread count was 8 (of 8 available processors)
```

```
 80
 81  Solution count 6: 893 2013 2133 ... 5293
 82
 83  Optimal solution found (tolerance 1.00e-10)
 84  Best objective 8.930000000000e+02, best bound 8.930000000000e+02, gap 0.0000%
 85  Set parameter MIPGap to value 1e-08
 86  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
 87
 88  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
 89  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
 90
 91  Optimize a model with 2481703 rows, 1955335 columns and 17236216 nonzeros
 92  Model fingerprint: 0x68d94f13
 93  Variable types: 963295 continuous, 992040 integer (985965 binary)
 94  Coefficient statistics:
 95    Matrix range     [1e-01, 1e+10]
 96    Objective range  [6e-05, 5e+01]
 97    Bounds range     [1e+00, 8e+01]
 98    RHS range        [8e-01, 1e+10]
 99  Warning: Model contains large matrix coefficients
100  Warning: Model contains large rhs
101           Consider reformulating model or setting NumericFocus parameter
102           to avoid numerical issues.
103  Presolve removed 2478029 rows and 1954013 columns (presolve time = 5s) ...
104  Presolve removed 2478029 rows and 1954013 columns
105  Presolve time: 5.48s
106  Presolved: 3674 rows, 1322 columns, 9781 nonzeros
107  Variable types: 8 continuous, 1314 integer (781 binary)
108  Found heuristic solution: objective 3324.0500186
109  Found heuristic solution: objective 3815.6702574
110
111  Root simplex log...
112
113  Iteration    Objective       Primal Inf.    Dual Inf.      Time
114         0    9.9372796e+03   3.480225e+03   0.000000e+00      7s
115      1135    5.2381303e+03   0.000000e+00   0.000000e+00      7s
116
117  Root relaxation: objective 5.238130e+03, 1135 iterations, 0.01 seconds (0.01 work units)
118
119      Nodes    |    Current Node    |     Objective Bounds      |     Work
120   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
121
122       0     0 5238.13028    0   47 3815.67026 5238.13028  37.3%     -    7s
123  H    0     0                    5222.7009882 5238.13028  0.30%     -    7s
124       0     0 5237.20528    0   12 5222.70099 5237.20528  0.28%     -    7s
125       0     0 5237.20528    0   12 5222.70099 5237.20528  0.28%     -    7s
126  H    0     0                    5235.3302838 5237.20528  0.04%     -    7s
127  H    0     0                    5236.7009882 5237.20528  0.01%     -    7s
128       0     0     cutoff    0      5236.70099 5236.70099  0.00%     -    7s
129
130  Cutting planes:
131    Learned: 10
132    Gomory: 1
133    Cover: 28
134    Implied bound: 33
135    Clique: 12
136    MIR: 6
137    Flow cover: 2
138    RLT: 6
139    Relax-and-lift: 20
140
141  Explored 1 nodes (1916 simplex iterations) in 7.44 seconds (7.31 work units)
142  Thread count was 8 (of 8 available processors)
143
144  Solution count 5: 5236.7 5235.33 5222.7 ... 3324.05
145
146  Optimal solution found (tolerance 1.00e-08)
147  Best objective 5.236700988201e+03, best bound 5.236700988201e+03, gap 0.0000%
148  SP is solved
149  SP's optimal solution is'□5236
150
151    Itr = 0
152  Collect_LB =   [893.0]
153  Collect_UB =   [11366.401976402522]
154  Collect_Hua =   [0.0]
155  Collect_SPObjVal =   [5236.700988201261]
156  Collect_MPObjValNHua =   [893.0]
157
158
159  Set parameter TimeLimit to value 12000
160  Set parameter MIPGap to value 0.0005
161  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
162
163  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 541394 rows, 283978 columns and 1505198 nonzeros
Model fingerprint: 0xd1609124
Variable types: 1 continuous, 283977 integer (283941 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 377861 rows and 265257 columns (presolve time = 5s) ...
Presolve removed 377861 rows and 265257 columns (presolve time = 10s) ...
Presolve removed 490283 rows and 275538 columns
Presolve time: 10.92s
Presolved: 51111 rows, 8440 columns, 131258 nonzeros
Variable types: 0 continuous, 8440 integer (8414 binary)
Root relaxation presolved: 8440 rows, 59551 columns, 139698 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0      handle free variables                         11s
    8144    6.1297010e+03   0.000000e+00   0.000000e+00     13s
    8144    6.1297010e+03   0.000000e+00   0.000000e+00     13s

Root relaxation: objective 6.129701e+03, 8144 iterations, 1.79 seconds (2.48 work units)

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

     0     0 6129.70099    0   13          - 6129.70099      -     -   13s
     0     0 6129.70099    0  400          - 6129.70099      -     -   16s
     0     0 6129.70099    0  345          - 6129.70099      -     -   16s
     0     0 6129.70099    0  249          - 6129.70099      -     -   16s
     0     0 6129.70099    0   35          - 6129.70099      -     -   19s
     0     0 6129.70099    0  282          - 6129.70099      -     -   20s
     0     0 6129.70099    0  307          - 6129.70099      -     -   20s
     0     0 6129.70099    0  214          - 6129.70099      -     -   21s
     0     0 6129.70099    0  111          - 6129.70099      -     -   23s
     0     0 6129.70099    0  110          - 6129.70099      -     -   23s
     0     0 6129.70099    0  190          - 6129.70099      -     -   24s
     0     0 6129.70099    0  120          - 6129.70099      -     -   24s
     0     0 6129.70099    0  118          - 6129.70099      -     -   24s
     0     0 6129.70099    0   25          - 6129.70099      -     -   25s
     0     0 6129.70099    0   25          - 6129.70099      -     -   26s
H    0     0                    6129.7009882 6129.70099  0.00%     -   27s
     0     0 6129.70099    0   25 6129.70099 6129.70099  0.00%     -   27s

Cutting planes:
  Learned: 1
  Gomory: 2
  Cover: 128
  Implied bound: 22
  Clique: 2538
  MIR: 120
  StrongCG: 80
  GUB cover: 3
  Zero half: 8
  RLT: 7
  Relax-and-lift: 17
  BQP: 2

Explored 1 nodes (40936 simplex iterations) in 27.27 seconds (30.07 work units)
Thread count was 8 (of 8 available processors)

Solution count 1: 6129.7

Optimal solution found (tolerance 5.00e-04)
Best objective 6.129700988201e+03, best bound 6.129700988201e+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 2481703 rows, 1955335 columns and 17236216 nonzeros
Model fingerprint: 0xb9a29d9f
Variable types: 963295 continuous, 992040 integer (985965 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 2476299 rows and 1953511 columns (presolve time = 5s) ...
Presolve removed 2476442 rows and 1953569 columns
Presolve time: 5.49s
Presolved: 5261 rows, 1766 columns, 14065 nonzeros
Variable types: 8 continuous, 1758 integer (1028 binary)
Found heuristic solution: objective 4330.7009882

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    1.0907280e+04   4.484819e+03   0.000000e+00      7s
    1592    6.0447010e+03   0.000000e+00   0.000000e+00      7s

Root relaxation: objective 6.044701e+03, 1592 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               0    6044.7009882 6044.70099  0.00%     -    7s

Explored 1 nodes (2084 simplex iterations) in 7.39 seconds (7.04 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 6044.7 4330.7

Optimal solution found (tolerance 1.00e-08)
Best objective 6.044700988201e+03, best bound 6.044700988201e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□6044

 Itr = 1
Collect_LB =   [893.0, 6129.700988201261]
Collect_UB =   [11366.401976402522, 6937.700988201261]
Collect_Hua =   [0.0, 5236.700988201261]
Collect_SPObjVal =   [5236.700988201261, 6044.700988201261]
Collect_MPObjValNHua =   [893.0, 893.0]


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 541395 rows, 283978 columns and 1505217 nonzeros
Model fingerprint: 0xd41571cb
Variable types: 1 continuous, 283977 integer (283941 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 377862 rows and 265257 columns (presolve time = 5s) ...
Presolve removed 462913 rows and 275538 columns (presolve time = 10s) ...
Presolve removed 490284 rows and 275538 columns
Presolve time: 10.31s
Presolved: 51111 rows, 8440 columns, 131258 nonzeros
Variable types: 0 continuous, 8440 integer (8414 binary)
Root relaxation presolved: 8440 rows, 59551 columns, 139698 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0     handle free variables                      11s
    8144    6.9377010e+03   0.000000e+00   0.000000e+00     12s
    8144    6.9377010e+03   0.000000e+00   0.000000e+00     12s

Root relaxation: objective 6.937701e+03, 8144 iterations, 1.74 seconds (2.48 work units)

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

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

     0     0 6937.70099    0   13          - 6937.70099      -     -   12s
     0     0 6937.70099    0  400          - 6937.70099      -     -   15s
     0     0 6937.70099    0  345          - 6937.70099      -     -   15s
     0     0 6937.70099    0  249          - 6937.70099      -     -   16s
     0     0 6937.70099    0   35          - 6937.70099      -     -   18s
     0     0 6937.70099    0  282          - 6937.70099      -     -   19s
     0     0 6937.70099    0  307          - 6937.70099      -     -   20s
     0     0 6937.70099    0  214          - 6937.70099      -     -   20s
     0     0 6937.70099    0  111          - 6937.70099      -     -   22s
     0     0 6937.70099    0  110          - 6937.70099      -     -   22s
     0     0 6937.70099    0  190          - 6937.70099      -     -   23s
     0     0 6937.70099    0  120          - 6937.70099      -     -   23s
     0     0 6937.70099    0  118          - 6937.70099      -     -   23s
     0     0 6937.70099    0   25          - 6937.70099      -     -   25s
     0     0 6937.70099    0   25          - 6937.70099      -     -   25s
H    0     0                    6937.7009882 6937.70099  0.00%     -   26s
     0     0 6937.70099    0   25 6937.70099 6937.70099  0.00%     -   26s

Cutting planes:
  Learned: 1
  Gomory: 2
  Cover: 128
  Implied bound: 22
  Clique: 2538
  MIR: 120
  StrongCG: 80
  GUB cover: 3
  Zero half: 8
  RLT: 7
  Relax-and-lift: 17
  BQP: 2

Explored 1 nodes (40936 simplex iterations) in 26.47 seconds (30.07 work units)
Thread count was 8 (of 8 available processors)

Solution count 1: 6937.7

Optimal solution found (tolerance 5.00e-04)
Best objective 6.937700988201e+03, best bound 6.937700988201e+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 2481703 rows, 1955335 columns and 17236216 nonzeros
Model fingerprint: 0xb9a29d9f
Variable types: 963295 continuous, 992040 integer (985965 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 2476304 rows and 1953511 columns (presolve time = 5s) ...
Presolve removed 2476442 rows and 1953569 columns
Presolve time: 5.37s
Presolved: 5261 rows, 1766 columns, 14065 nonzeros
Variable types: 8 continuous, 1758 integer (1028 binary)
Found heuristic solution: objective 4330.7009882

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    1.0907280e+04   4.484819e+03   0.000000e+00      7s
    1592    6.0447010e+03   0.000000e+00   0.000000e+00      7s

Root relaxation: objective 6.044701e+03, 1592 iterations, 0.03 seconds (0.02 work units)

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

*    0     0               0    6044.7009882 6044.70099  0.00%     -    6s

Explored 1 nodes (2084 simplex iterations) in 7.21 seconds (7.04 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 6044.7 4330.7

```

```
Optimal solution found (tolerance 1.00e-08)
Best objective 6.044700988201e+03, best bound 6.044700988201e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□6044

 Itr = 2
Collect_LB =  [893.0, 6129.700988201261, 6937.700988201261]
Collect_UB =  [11366.401976402522, 6937.700988201261, 6937.700988201261]
Collect_Hua =  [0.0, 5236.700988201261, 6044.700988201261]
Collect_SPObjVal =  [5236.700988201261, 6044.700988201261, 6044.700988201261]
Collect_MPObjValNHua =  [893.0, 893.0, 893.0]


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

~~~~~~~~~~judge = 2, SPObj_SPF = 6044.700988201261
Vessel i: 0:    pi: 0-5,    ai-di: 54-79,    gi_SP-gpi_SP: 0.000000-0.000000,    ai_SP-di: 54-79,    taoi-deltai: 54-68,    taoPi_SP-deltaPi_SP: 54-68,    betaNi: 14,    bi: 14
Vessel i: 1:    pi: 0-6,    ai-di: 11-34,    gi_SP-gpi_SP: 0.000000-0.000000,    ai_SP-di: 11-34,    taoi-deltai: 11-31,    taoPi_SP-deltaPi_SP: 11-31,    betaNi: 20,    bi: 20
Vessel i: 2:    pi: 6-11,    ai-di: 13-21,    gi_SP-gpi_SP: 0.000000-0.000000,    ai_SP-di: 13-21,    taoi-deltai: 13-19,    taoPi_SP-deltaPi_SP: 13-19,    betaNi: 6,    bi: 6
Vessel i: 3:    pi: 5-12,    ai-di: 47-82,    gi_SP-gpi_SP: 0.000000-0.000000,    ai_SP-di: 47-82,    taoi-deltai: 47-71,    taoPi_SP-deltaPi_SP: 47-71,    betaNi: 24,    bi: 24
Vessel i: 4:    pi: 6-11,    ai-di: 33-46,    gi_SP-gpi_SP: 0.000000-0.000000,    ai_SP-di: 33-46,    taoi-deltai: 33-38,    taoPi_SP-deltaPi_SP: 33-38,    betaNi: 5,    bi: 5
Vessel i: 5:    pi: 3-8,    ai-di: 40-55,    gi_SP-gpi_SP: 0.000000-1.000000,    ai_SP-di: 40-55,    taoi-deltai: 40-45,    taoPi_SP-deltaPi_SP: 40-45,    betaNi: 5,    bi: 5
Vessel i: 6:    pi: 14-20,    ai-di: 9-31,    gi_SP-gpi_SP: 0.500000-0.100000,    ai_SP-di: 13-31,    taoi-deltai: 13-27,    taoPi_SP-deltaPi_SP: 13-27,    betaNi: 14,    bi: 14
Vessel i: 7:    pi: 27-34,    ai-di: 13-47,    gi_SP-gpi_SP: 0.900000-0.700000,    ai_SP-di: 22-47,    taoi-deltai: 22-47,    taoPi_SP-deltaPi_SP: 22-47,    betaNi: 25,    bi: 25
Vessel i: 8:    pi: 15-22,    ai-di: 36-72,    gi_SP-gpi_SP: 1.000000-0.600000,    ai_SP-di: 43-72,    taoi-deltai: 43-71,    taoPi_SP-deltaPi_SP: 43-71,    betaNi: 28,    bi: 28

round LB =  [893, 6130, 6938]
round UB =  [11366, 6938, 6938]
round Hua =  [0, 5237, 6045]
round SPObjVal =  [5237, 6045, 6045]
round MPObjValNHua =  [893, 893, 893]

OptimalObj = 6937.700988201261
Time: 610.000000
```