```
"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=51878

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 455904 rows, 40692 columns and 1255082 nonzeros
Model fingerprint: 0x0544b721
Variable types: 1 continuous, 40691 integer (40663 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 302987 rows and 21615 columns (presolve time = 5s) ...
Presolve removed 405682 rows and 29722 columns
Presolve time: 6.23s
Presolved: 50222 rows, 10970 columns, 163928 nonzeros
Variable types: 0 continuous, 10970 integer (10949 binary)

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

Root relaxation presolved: 50219 rows, 10973 columns, 163919 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    5.3800000e+02   6.831250e+01   1.510929e+08      7s
Concurrent spin time: 0.01s

Solved with dual simplex (primal model)

Root relaxation: objective 5.380000e+02, 1854 iterations, 0.22 seconds (0.20 work units)

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

     0     0  538.00000    0    9          -  538.00000      -     -    7s
H    0     0                    1098.0000000  538.00000  51.0%     -    7s
H    0     0                    1058.0000000  538.00000  49.1%     -    7s
H    0     0                     818.0000000  538.00000  34.2%     -    7s
H    0     0                     618.0000000  538.00000  12.9%     -    7s
H    0     0                     538.0000000  538.00000  0.00%     -    7s
     0     0  538.00000    0   42  538.00000  538.00000  0.00%     -    7s

Cutting planes:
  Gomory: 3
  Cover: 72
  Implied bound: 2
  Clique: 2
  MIR: 4
  StrongCG: 7
  GUB cover: 1
  Zero half: 1
  RLT: 2
  Relax-and-lift: 5

Explored 1 nodes (8791 simplex iterations) in 7.75 seconds (13.23 work units)
Thread count was 8 (of 8 available processors)

Solution count 5: 538 618 818 ... 1098

```

```
Optimal solution found (tolerance 1.00e-10)
Best objective 5.380000000000e+02, best bound 5.380000000000e+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 1540878 rows, 1208299 columns and 10558838 nonzeros
Model fingerprint: 0xf8024e31
Variable types: 592971 continuous, 615328 integer (610603 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 1539921 rows and 1207950 columns
Presolve time: 3.41s
Presolved: 957 rows, 349 columns, 2567 nonzeros
Variable types: 0 continuous, 349 integer (203 binary)
Found heuristic solution: objective 3293.6923132
Found heuristic solution: objective 3403.6923132

Root relaxation: objective 3.755692e+03, 245 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                    3755.6923132 5535.69231  47.4%     -    4s
     0     0        -    0      3755.69231 3755.69231  0.00%     -    4s

Explored 1 nodes (328 simplex iterations) in 4.39 seconds (4.51 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 3755.69 3403.69 3293.69

Optimal solution found (tolerance 1.00e-08)
Best objective 3.755692313203e+03, best bound 3.755692313203e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□3755

  Itr = 0
Collect_LB =   [538.0]
Collect_UB =   [8049.384626406987]
Collect_Hua =   [0.0]
Collect_SPObjVal =   [3755.6923132034935]
Collect_MPObjValNHua =   [538.0]


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 459707 rows, 180636 columns and 1258920 nonzeros
Model fingerprint: 0x981531c3
Variable types: 1 continuous, 180635 integer (180607 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 341196 rows and 166583 columns (presolve time = 5s) ...
Presolve removed 420685 rows and 174163 columns
Presolve time: 6.12s
Presolved: 39022 rows, 6473 columns, 100972 nonzeros
Variable types: 0 continuous, 6473 integer (6452 binary)
Root relaxation presolved: 6473 rows, 45495 columns, 107445 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0     handle free variables                          6s
```

```
164      4432    4.2961923e+03   0.000000e+00   0.000000e+00      7s
165      4432    4.2961923e+03   0.000000e+00   0.000000e+00      7s
166
167   Root relaxation: objective 4.296192e+03, 4432 iterations, 0.43 seconds (0.78 work units)
168
169      Nodes    |    Current Node    |     Objective Bounds      |     Work
170   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
171
172      0     0 4296.19231    0   16          - 4296.19231      -     -    6s
173   H    0     0                    4436.1923132 4296.19231  3.16%     -    7s
174      0     0 4296.19231    0   25 4436.19231 4296.19231  3.16%     -    7s
175      0     0 4296.19231    0   40 4436.19231 4296.19231  3.16%     -    7s
176      0     0 4296.19231    0   29 4436.19231 4296.19231  3.16%     -    7s
177   H    0     0                    4416.1923132 4296.19231  2.72%     -    7s
178      0     0 4296.19231    0   83 4416.19231 4296.19231  2.72%     -    7s
179      0     0 4296.19231    0    5 4416.19231 4296.19231  2.72%     -    8s
180   H    0     0                    4396.1923132 4296.19231  2.27%     -    8s
181   H    0     0                    4316.1923132 4296.19231  0.46%     -    8s
182      0     0 4296.19231    0   68 4316.19231 4296.19231  0.46%     -    8s
183      0     0 4296.19231    0   17 4316.19231 4296.19231  0.46%     -    8s
184      0     0 4296.19231    0   29 4316.19231 4296.19231  0.46%     -    8s
185   H    0     0                    4296.1923132 4296.19231  0.00%     -    8s
186
187   Cutting planes:
188     Learned: 1
189     Gomory: 17
190     Cover: 87
191     Implied bound: 4
192     Clique: 15
193     MIR: 57
194     StrongCG: 38
195     GUB cover: 2
196     Zero half: 5
197     RLT: 6
198     Relax-and-lift: 9
199
200   Explored 1 nodes (12871 simplex iterations) in 8.80 seconds (14.56 work units)
201   Thread count was 8 (of 8 available processors)
202
203   Solution count 5: 4296.19 4316.19 4396.19 ... 4436.19
204
205   Optimal solution found (tolerance 5.00e-04)
206   Best objective 4.296192313203e+03, best bound 4.296192313203e+03, gap 0.0000%
207   Set parameter MIPGap to value 1e-08
208   Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
209
210   CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
211   Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
212
213   Optimize a model with 1540878 rows, 1208299 columns and 10558838 nonzeros
214   Model fingerprint: 0xc985fe0a
215   Variable types: 592971 continuous, 615328 integer (610603 binary)
216   Coefficient statistics:
217     Matrix range     [1e-01, 1e+10]
218     Objective range  [6e-05, 5e+01]
219     Bounds range     [1e+00, 8e+01]
220     RHS range        [8e-01, 1e+10]
221   Warning: Model contains large matrix coefficients
222   Warning: Model contains large rhs
223           Consider reformulating model or setting NumericFocus parameter
224           to avoid numerical issues.
225   Presolve removed 1539641 rows and 1207866 columns
226   Presolve time: 3.25s
227   Presolved: 1237 rows, 433 columns, 3330 nonzeros
228   Variable types: 0 continuous, 433 integer (254 binary)
229   Found heuristic solution: objective 3569.2222222
230
231   Root relaxation: objective 4.125222e+03, 249 iterations, 0.00 seconds (0.00 work units)
232
233      Nodes    |    Current Node    |     Objective Bounds      |     Work
234   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
235
236   *    0     0               0    4125.2222222 4125.22222  0.00%     -    4s
237
238   Explored 1 nodes (249 simplex iterations) in 4.23 seconds (4.36 work units)
239   Thread count was 8 (of 8 available processors)
240
241   Solution count 2: 4125.22 3569.22
242
243   Optimal solution found (tolerance 1.00e-08)
244   Best objective 4.125222222222e+03, best bound 4.125222222222e+03, gap 0.0000%
245   SP is solved
246   SP's optimal solution is'□4125
247
```

```
 Itr = 1
Collect_LB =   [538.0, 4296.1923132034935]
Collect_UB =   [8049.384626406987, 4665.7222222222221]
Collect_Hua =   [0.0, 3755.6923132034935]
Collect_SPObjVal =   [3755.6923132034935, 4125.222222222221]
Collect_MPObjValNHua =   [538.0, 540.5]


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 459708 rows, 180636 columns and 1258935 nonzeros
Model fingerprint: 0x0852b1d5
Variable types: 1 continuous, 180635 integer (180607 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 341860 rows and 166624 columns (presolve time = 5s) ...
Presolve removed 421056 rows and 174215 columns
Presolve time: 5.96s
Presolved: 38652 rows, 6421 columns, 100028 nonzeros
Variable types: 0 continuous, 6421 integer (6400 binary)
Root relaxation presolved: 6421 rows, 45073 columns, 106449 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0      handle free variables                         6s
    4859    4.6657222e+03   0.000000e+00   0.000000e+00      7s
    4859    4.6657222e+03   0.000000e+00   0.000000e+00      7s

Root relaxation: objective 4.665722e+03, 4859 iterations, 0.44 seconds (0.90 work units)

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

     0     0 4665.72222    0   10          - 4665.72222      -     -    6s
     0     0 4665.72222    0   27          - 4665.72222      -     -    7s
     0     0 4665.72222    0   48          - 4665.72222      -     -    7s
H    0     0                5145.7222222 4665.72222  9.33%     -    7s
     0     0 4665.72222    0   47 5145.72222 4665.72222  9.33%     -    7s
     0     0 4665.72222    0   47 5145.72222 4665.72222  9.33%     -    7s
     0     0 4665.72222    0   47 5145.72222 4665.72222  9.33%     -    7s
H    0     0                4905.7222222 4665.72222  4.89%     -    8s
     0     0 4665.72222    0   18 4905.72222 4665.72222  4.89%     -    8s
     0     0 4665.72222    0   19 4905.72222 4665.72222  4.89%     -    8s
     0     0 4665.72222    0   19 4905.72222 4665.72222  4.89%     -    8s
     0     0 4665.72222    0   28 4905.72222 4665.72222  4.89%     -    8s
     0     0 4665.72222    0  103 4905.72222 4665.72222  4.89%     -    8s
     0     0 4665.72222    0    9 4905.72222 4665.72222  4.89%     -    9s
     0     0 4665.72222    0   66 4905.72222 4665.72222  4.89%     -    9s
     0     0 4665.72222    0  178 4905.72222 4665.72222  4.89%     -   10s
H    0     0                4665.7222222 4665.72222  0.00%     -   10s
     0     0 4665.72222    0    6 4665.72222 4665.72222  0.00%     -   10s

Cutting planes:
  Learned: 3
  Gomory: 54
  Cover: 237
  Implied bound: 19
  Clique: 101
  MIR: 84
  StrongCG: 60
  GUB cover: 6
  Zero half: 16
  RLT: 1
  Relax-and-lift: 48

Explored 1 nodes (27017 simplex iterations) in 10.34 seconds (17.14 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 4665.72 4905.72 5145.72

```

```
Optimal solution found (tolerance 5.00e-04)
Best objective 4.665722222222e+03, best bound 4.665722222222e+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 1540878 rows, 1208299 columns and 10558838 nonzeros
Model fingerprint: 0xee58bb4a
Variable types: 592971 continuous, 615328 integer (610603 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 1537728 rows and 1207176 columns
Presolve time: 3.07s
Presolved: 3150 rows, 1123 columns, 8375 nonzeros
Variable types: 6 continuous, 1117 integer (656 binary)
Found heuristic solution: objective 2847.8034243

Root relaxation: objective 4.145222e+03, 955 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 4145.22222    0   76 2847.80342 4145.22222  45.6%     -    3s
H    0     0                3847.5812021 4145.22222  7.74%     -    3s
     0     0 4140.09911    0   70 3847.58120 4140.09911  7.60%     -    3s
H    0     0                4121.8034243 4140.09911  0.44%     -    3s
H    0     0                4130.6923132 4140.09911  0.23%     -    4s
     0     0 4140.09911    0   48 4130.69231 4140.09911  0.23%     -    4s
*    0     0               0    4135.6923132 4135.69231  0.00%     -    4s

Cutting planes:
  Learned: 2
  Gomory: 8
  Cover: 12
  Implied bound: 1
  Clique: 38
  MIR: 2
  Zero half: 10
  Relax-and-lift: 1

Explored 1 nodes (1630 simplex iterations) in 4.18 seconds (4.28 work units)
Thread count was 8 (of 8 available processors)

Solution count 5: 4135.69 4130.69 4121.8 ... 2847.8

Optimal solution found (tolerance 1.00e-08)
Best objective 4.135692313203e+03, best bound 4.135692313203e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□4135

 Itr = 2
Collect_LB =   [538.0, 4296.1923132034935, 4665.722222222221]
Collect_UB =   [8049.384626406987, 4665.722222222221, 4665.722222222221]
Collect_Hua =   [0.0, 3755.6923132034935, 4125.222222222221]
Collect_SPObjVal =   [3755.6923132034935, 4125.222222222221, 4135.6923132034935]
Collect_MPObjValNHua =   [538.0, 540.5, 540.5]


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

~~~~~~~~~~judge = 2, SPObj_SPF = 4135.6923132034935
Vessel i: 0:     pi: 0-5,     ai-di: 2-10,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 2-10,     taoi-deltai: 2-8,     taoPi_SP-deltaPi_SP: 2-8,     betaNi: 6,     bi: 6
Vessel i: 1:     pi: 17-24,     ai-di: 1-25,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 1-25,     taoi-deltai: 1-23,     taoPi_SP-deltaPi_SP: 1-23,     betaNi: 22,     bi: 22
Vessel i: 2:     pi: 24-29,     ai-di: 3-10,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 3-10,     taoi-deltai: 3-8,     taoPi_SP-deltaPi_SP: 3-8,     betaNi: 5,     bi: 5
Vessel i: 3:     pi: 12-17,     ai-di: 22-40,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 22-40,     taoi-deltai: 22-38,     taoPi_SP-deltaPi_SP: 22-38,     betaNi: 16,     bi: 16
Vessel i: 4:     pi: 24-29,     ai-di: 20-45,     gi_SP-gpi_SP: 0.175000-0.276099,     ai_SP-di: 20-45,     taoi-deltai: 22-31,     taoPi_SP-deltaPi_SP: 22-31,     betaNi: 9,     bi: 9
Vessel i: 5:     pi: 27-34,     ai-di: 28-68,     gi_SP-gpi_SP: 0.625000-0.975000,     ai_SP-di: 33-68,     taoi-deltai: 33-55,     taoPi_SP-deltaPi_SP: 33-55,     betaNi: 22,     bi: 22
Vessel i: 6:     pi: 14-19,     ai-di: 35-65,     gi_SP-gpi_SP: 1.000000-0.548901,     ai_SP-di: 45-65,     taoi-deltai: 43-53,     taoPi_SP-deltaPi_SP: 45-53,
```

```
409  betaNi: 10,      bi: 10
410
411  round LB =   [538, 4296, 4666]
412  round UB =   [8049, 4666, 4666]
413  round Hua =   [0, 3756, 4125]
414  round SPObjVal =   [3756, 4125, 4136]
415  round MPObjValNHua =   [538, 540, 540]
416
417  OptimalObj = 4665.722222222221
418  Time: 312.000000
419
420
421
422
```