```
"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=51502

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 457807 rows, 40692 columns and 1261015 nonzeros
Model fingerprint: 0x26b91638
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 249913 rows and 15536 columns (presolve time = 5s) ...
Presolve removed 409264 rows and 27025 columns
Presolve time: 8.02s
Presolved: 48543 rows, 13667 columns, 189280 nonzeros
Variable types: 0 continuous, 13667 integer (13646 binary)

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

Root relaxation presolved: 48542 rows, 13668 columns, 189277 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    9.3400000e+02   1.238750e+02   2.438428e+08      8s
Concurrent spin time: 0.00s

Solved with dual simplex (primal model)

Root relaxation: objective 9.340000e+02, 3187 iterations, 0.39 seconds (0.44 work units)

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

     0     0  934.00000    0   19          -  934.00000      -     -    9s
     0     0  934.00000    0   62          -  934.00000      -     -    9s
     0     0  934.00000    0   67          -  934.00000      -     -    9s
H    0     0                     934.0000000  934.00000  0.00%     -   11s
     0     0  934.00000    0   62  934.00000  934.00000  0.00%     -   12s

Cutting planes:
  Gomory: 7
  Lift-and-project: 1
  Cover: 160
  Implied bound: 494
  Clique: 38
  MIR: 88
  StrongCG: 23
  GUB cover: 26
  Zero half: 3
  RLT: 13
  Relax-and-lift: 19
  PSD: 1

Explored 1 nodes (18522 simplex iterations) in 12.12 seconds (19.11 work units)
Thread count was 8 (of 8 available processors)

Solution count 1: 934

```

```
Optimal solution found (tolerance 1.00e-10)
Best objective 9.340000000000e+02, best bound 9.340000000000e+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 1540865 rows, 1208299 columns and 10558786 nonzeros
Model fingerprint: 0x460a495d
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 1536425 rows and 1206773 columns
Presolve time: 3.58s
Presolved: 4440 rows, 1526 columns, 11883 nonzeros
Variable types: 6 continuous, 1520 integer (899 binary)
Found heuristic solution: objective 4826.5486169

Root relaxation: objective 6.398549e+03, 1326 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    6398.5486169 6398.54862  0.00%     -    4s

Explored 1 nodes (1693 simplex iterations) in 4.76 seconds (4.75 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 6398.55 4826.55

Optimal solution found (tolerance 1.00e-08)
Best objective 6.398548616906e+03, best bound 6.398548616906e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□6398

  Itr = 0
Collect_LB =   [934.0]
Collect_UB =   [13731.097233811925]
Collect_Hua =   [0.0]
Collect_SPObjVal =   [6398.548616905962]
Collect_MPObjValNHua =   [934.0]


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 462052 rows, 180636 columns and 1265295 nonzeros
Model fingerprint: 0xdcfd27e4
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 286356 rows and 160742 columns (presolve time = 5s) ...
Presolve removed 286356 rows and 160742 columns (presolve time = 10s) ...
Presolve removed 438281 rows and 172449 columns
Presolve time: 11.32s
Presolved: 23771 rows, 8187 columns, 100931 nonzeros
Variable types: 0 continuous, 8187 integer (8168 binary)

Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    7.3845486e+03   9.987500e+02   0.000000e+00     12s
    3567    7.3845486e+03   0.000000e+00   0.000000e+00     12s

Root relaxation: objective 7.384549e+03, 3567 iterations, 0.09 seconds (0.10 work units)
```

```
164
165      Nodes    |    Current Node    |    Objective Bounds      |     Work
166   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
167
168      0     0 7384.54862    0   25          - 7384.54862      -     -   11s
169      0     0 7384.54862    0   26          - 7384.54862      -     -   11s
170      0     0 7384.54862    0   62          - 7384.54862      -     -   12s
171      0     0 7384.54862    0  132          - 7384.54862      -     -   13s
172      0     0 7384.54862    0  126          - 7384.54862      -     -   13s
173  H   0     0                 8464.5486169 7384.54862  12.8%     -   15s
174      0     0 7384.54862    0  111 8464.54862 7384.54862  12.8%     -   16s
175      0     0 7384.54862    0  110 8464.54862 7384.54862  12.8%     -   16s
176      0     0 7384.54862    0  468 8464.54862 7384.54862  12.8%     -   17s
177      0     0 7384.54862    0  305 8464.54862 7384.54862  12.8%     -   18s
178      0     0 7384.54862    0  269 8464.54862 7384.54862  12.8%     -   18s
179  H   0     0                 7384.5486169 7384.54862  0.00%     -   20s
180      0     0 7384.54862    0   60 7384.54862 7384.54862  0.00%     -   20s
181
182  Cutting planes:
183    Learned: 1
184    Gomory: 3
185    Lift-and-project: 1
186    Cover: 116
187    Implied bound: 662
188    Clique: 1865
189    MIR: 178
190    StrongCG: 140
191    GUB cover: 12
192    Zero half: 13
193    RLT: 11
194    Relax-and-lift: 25
195    BQP: 26
196    PSD: 5
197
198  Explored 1 nodes (50235 simplex iterations) in 20.61 seconds (26.07 work units)
199  Thread count was 8 (of 8 available processors)
200
201  Solution count 2: 7384.55 8464.55
202
203  Optimal solution found (tolerance 5.00e-04)
204  Best objective 7.384548616906e+03, best bound 7.384548616906e+03, gap 0.0000%
205  Set parameter MIPGap to value 1e-08
206  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
207
208  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
209  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
210
211  Optimize a model with 1540865 rows, 1208299 columns and 10558786 nonzeros
212  Model fingerprint: 0x5f04e3aa
213  Variable types: 592971 continuous, 615328 integer (610603 binary)
214  Coefficient statistics:
215    Matrix range     [1e-01, 1e+10]
216    Objective range  [6e-05, 5e+01]
217    Bounds range     [1e+00, 8e+01]
218    RHS range        [8e-01, 1e+10]
219  Warning: Model contains large matrix coefficients
220  Warning: Model contains large rhs
221           Consider reformulating model or setting NumericFocus parameter
222           to avoid numerical issues.
223  Presolve removed 1534438 rows and 1206171 columns
224  Presolve time: 3.17s
225  Presolved: 6427 rows, 2128 columns, 17197 nonzeros
226  Variable types: 6 continuous, 2122 integer (1228 binary)
227  Found heuristic solution: objective 4845.9988688
228
229  Root relaxation: objective 6.867000e+03, 1883 iterations, 0.02 seconds (0.02 work units)
230
231      Nodes    |    Current Node    |    Objective Bounds      |     Work
232   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
233
234      0     0 6867.00000    0   16 4845.99887 6867.00000  41.7%     -    4s
235  H   0     0                 6102.3983621 6867.00000  12.5%     -    4s
236  H   0     0                 6154.2222222 6867.00000  11.6%     -    4s
237      0     0 6867.00000    0   26 6154.22222 6867.00000  11.6%     -    4s
238  H   0     0                 6491.0000000 6867.00000  5.79%     -    4s
239  H   0     0                 6866.4882982 6867.00000  0.01%     -    4s
240  H   0     0                 6867.0000000 6867.00000  0.00%     -    4s
241
242  Cutting planes:
243    Gomory: 2
244    Cover: 13
245    Implied bound: 5
246    Clique: 1
247    Zero half: 2
```

```
248
249  Explored 1 nodes (3492 simplex iterations) in 4.37 seconds (4.51 work units)
250  Thread count was 8 (of 8 available processors)
251
252  Solution count 6: 6867 6866.49 6491 ... 4846
253
254  Optimal solution found (tolerance 1.00e-08)
255  Best objective 6.867000000000e+03, best bound 6.867000000000e+03, gap 0.0000%
256  SP is solved
257  SP's optimal solution is'□6867
258
259   Itr = 1
260  Collect_LB =   [934.0, 7384.548616905962]
261  Collect_UB =   [13731.097233811925, 7853.000000000004]
262  Collect_Hua =   [0.0, 6398.548616905962]
263  Collect_SPObjVal =   [6398.548616905962, 6867.000000000004]
264  Collect_MPObjValNHua =   [934.0, 986.0]
265
266
267  Set parameter TimeLimit to value 12000
268  Set parameter MIPGap to value 0.0005
269  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
270
271  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
272  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
273
274  Optimize a model with 462053 rows, 180636 columns and 1265310 nonzeros
275  Model fingerprint: 0x92616ba7
276  Variable types: 1 continuous, 180635 integer (180607 binary)
277  Coefficient statistics:
278    Matrix range     [1e+00, 1e+10]
279    Objective range  [1e+00, 2e+01]
280    Bounds range     [1e+00, 1e+00]
281    RHS range        [1e+00, 2e+10]
282  Warning: Model contains large matrix coefficients
283  Warning: Model contains large rhs
284           Consider reformulating model or setting NumericFocus parameter
285           to avoid numerical issues.
286  Presolve removed 286357 rows and 160742 columns (presolve time = 5s) ...
287  Presolve removed 438282 rows and 172449 columns
288  Presolve time: 8.91s
289  Presolved: 23771 rows, 8187 columns, 100931 nonzeros
290  Variable types: 0 continuous, 8187 integer (8168 binary)
291
292  Root simplex log...
293
294  Iteration    Objective       Primal Inf.    Dual Inf.      Time
295         0    7.8530000e+03   9.987500e+02   0.000000e+00      9s
296      3567    7.8530000e+03   0.000000e+00   0.000000e+00      9s
297
298  Root relaxation: objective 7.853000e+03, 3567 iterations, 0.08 seconds (0.10 work units)
299
300      Nodes    |    Current Node    |     Objective Bounds      |     Work
301   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
302
303       0     0 7853.00000    0   25          - 7853.00000      -     -    9s
304       0     0 7853.00000    0   26          - 7853.00000      -     -    9s
305       0     0 7853.00000    0   62          - 7853.00000      -     -   10s
306       0     0 7853.00000    0  132          - 7853.00000      -     -   10s
307       0     0 7853.00000    0  126          - 7853.00000      -     -   10s
308  H    0     0                 8933.0000000 7853.00000  12.1%     -   13s
309       0     0 7853.00000    0  111 8933.00000 7853.00000  12.1%     -   13s
310       0     0 7853.00000    0  110 8933.00000 7853.00000  12.1%     -   13s
311       0     0 7853.00000    0  468 8933.00000 7853.00000  12.1%     -   15s
312       0     0 7853.00000    0  305 8933.00000 7853.00000  12.1%     -   15s
313       0     0 7853.00000    0  269 8933.00000 7853.00000  12.1%     -   16s
314  H    0     0                 7853.0000000 7853.00000  0.00%     -   18s
315       0     0 7853.00000    0   60 7853.00000 7853.00000  0.00%     -   18s
316
317  Cutting planes:
318    Learned: 1
319    Gomory: 3
320    Lift-and-project: 1
321    Cover: 116
322    Implied bound: 662
323    Clique: 1865
324    MIR: 178
325    StrongCG: 140
326    GUB cover: 12
327    Zero half: 13
328    RLT: 11
329    Relax-and-lift: 25
330    BQP: 26
331    PSD: 5
```

```
Explored 1 nodes (50235 simplex iterations) in 18.25 seconds (26.07 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 7853 8933

Optimal solution found (tolerance 5.00e-04)
Best objective 7.853000000000e+03, best bound 7.853000000000e+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 1540865 rows, 1208299 columns and 10558786 nonzeros
Model fingerprint: 0x5f04e3aa
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 1534438 rows and 1206171 columns
Presolve time: 3.17s
Presolved: 6427 rows, 2128 columns, 17197 nonzeros
Variable types: 6 continuous, 2122 integer (1228 binary)
Found heuristic solution: objective 4845.9988688

Root relaxation: objective 6.867000e+03, 1883 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 6867.00000    0   16 4845.99887 6867.00000  41.7%     -    4s
H    0     0                6102.3983621 6867.00000  12.5%     -    4s
H    0     0                6154.2222222 6867.00000  11.6%     -    4s
     0     0 6867.00000    0   26 6154.22222 6867.00000  11.6%     -    4s
H    0     0                6491.0000000 6867.00000  5.79%     -    4s
H    0     0                6866.4882982 6867.00000  0.01%     -    4s
H    0     0                6867.0000000 6867.00000  0.00%     -    4s

Cutting planes:
  Gomory: 2
  Cover: 13
  Implied bound: 5
  Clique: 1
  Zero half: 2

Explored 1 nodes (3492 simplex iterations) in 4.39 seconds (4.51 work units)
Thread count was 8 (of 8 available processors)

Solution count 6: 6867 6866.49 6491 ... 4846

Optimal solution found (tolerance 1.00e-08)
Best objective 6.867000000000e+03, best bound 6.867000000000e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□6867

 Itr = 2
Collect_LB =   [934.0, 7384.548616905962, 7853.000000000004]
Collect_UB =   [13731.097233811925, 7853.000000000004, 7853.000000000004]
Collect_Hua =   [0.0, 6398.548616905962, 6867.000000000004]
Collect_SPObjVal =   [6398.548616905962, 6867.000000000004, 6867.000000000004]
Collect_MPObjValNHua =   [934.0, 986.0, 986.0]


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

~~~~~~~~~~judge = 2, SPObj_SPF = 6867.000000000004
Vessel i: 0:     pi: 0-7,     ai-di: 1-33,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 1-33,     taoi-deltai: 1-32,     taoPi_SP-deltaPi_SP: 1-32,     betaNi: 31,     bi: 31
Vessel i: 1:     pi: 8-13,     ai-di: 5-33,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 5-33,     taoi-deltai: 5-31,     taoPi_SP-deltaPi_SP: 5-31,     betaNi: 26,     bi: 26
Vessel i: 2:     pi: 13-18,     ai-di: 7-24,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 7-24,     taoi-deltai: 7-22,     taoPi_SP-deltaPi_SP: 7-22,     betaNi: 15,     bi: 15
Vessel i: 3:     pi: 20-27,     ai-di: 13-50,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 13-50,     taoi-deltai: 13-48,     taoPi_SP-deltaPi_SP: 13-48,     betaNi: 35,     bi: 35
Vessel i: 4:     pi: 13-19,     ai-di: 26-40,     gi_SP-gpi_SP: 0.000000-0.400000,     ai_SP-di: 26-40,     taoi-deltai: 26-38,     taoPi_SP-deltaPi_SP: 26-38,     betaNi: 12,     bi: 12
```

```
Vessel i: 5:    pi: 10-15,    ai-di: 32-48,    gi_SP-gpi_SP: 0.800000-0.800000,    ai_SP-di: 38-48,    taoi-deltai: 39-50,    taoPi_SP-deltaPi_SP: 40-50,
    betaNi: 11,    bi: 11
Vessel i: 6:    pi: 15-20,    ai-di: 40-78,    gi_SP-gpi_SP: 1.000000-0.600000,    ai_SP-di: 50-78,    taoi-deltai: 50-78,    taoPi_SP-deltaPi_SP: 50-78,
    betaNi: 28,    bi: 28

round LB =  [934, 7385, 7853]
round UB =  [13731, 7853, 7853]
round Hua =  [0, 6399, 6867]
round SPObjVal =  [6399, 6867, 6867]
round MPObjValNHua =  [934, 986, 986]

OptimalObj = 7853.000000000004
Time: 350.000000
```