```
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=23122
 3
     import sys; print('Python %s on %s' % (sys.version, sys.platform))
     sys.path.extend(|'E:\\1 000\\3 0000\\1 00000\\1 000000\\1 00000\\1 LW 0000\\4 0000\\3 python code\\9 Code for this
     6
     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
 8
     >>> runfile('E:/1 000/3 0000/1 00000/1 00000/1 00000/1 00000/1 LW_000/4 000/3 python_code/9 Code for this paper/main_RO_CCG.py', wdir='E:/1 0000/3 0000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 000000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 000000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00000/1 00
     this paper'
    Backend TkAgg is interactive backend. Turning interactive mode on.
     Waiting 5s.....
     Set parameter MIPGap to value 1e-10
12
     Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
13
15
     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
16
17
     Optimize a model with 599385 rows, 52642 columns and 1660437 nonzeros
19
     Model fingerprint: 0xa7479769
     Variable types: 1 continuous, 52641 integer (52605 binary)
20
21
     Coefficient statistics:
      Matrix range [1e+00, 1e+10]
       Objective range [1e+00, 2e+01]
23
24
       Bounds range [1e+00, 1e+00]
                            [1e+00, 2e+10]
       RHS range
26
      Warning: Model contains large matrix coefficients
27
      Warning: Model contains large rhs
28
             Consider reformulating model or setting NumericFocus parameter
29
             to avoid numerical issues.
30
     Presolve removed 370756 rows and 24895 columns (presolve time = 5s) ...
     Presolve removed 530972 rows and 37088 columns
31
     Presolve time: 9.01s
     Presolved: 68413 rows, 15554 columns, 230775 nonzeros
34
      Variable types: 0 continuous, 15554 integer (15527 binary)
35
     Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
37
     Showing first log only...
38
39
     Root relaxation presolved: 15554 rows, 83967 columns, 246329 nonzeros
40
41
42
     Root simplex log...
43
44
     Iteration Objective
                                      Primal Inf. Dual Inf.
           0 6.4700000e+02 0.000000e+00 9.240000e+02
45
46
     Concurrent spin time: 0.00s
48
     Solved with dual simplex (primal model)
49
50
     Root relaxation: objective 6.470000e+02, 2678 iterations, 0.30 seconds (0.31 work units)
51
     Total elapsed time = 10.05s
52
53
         Nodes | Current Node | Objective Bounds |
                                                                                   Work
54
      Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
55
         0 0 647.00000 0 12
56
                                                   - 647.00000
                                   1527.0000000 647.00000 57.6% - 10s
57 H 0 0
58 H 0 0
                                    947.0000000 647.00000 31.7% - 10s
59 H 0 0
                                    787.0000000 647.00000 17.8%
                                                                                  - 11s
         0 0 647.00000 0 68 787.00000 647.00000 17.8% - 11s
60
61 H 0 0
                                    747.0000000 647.00000 13.4% - 11s
62 H 0
                                    727.0000000 647.00000 11.0%
         0 0 647.00000 0 67 727.00000 647.00000 11.0% - 11s
63
64 H 0 0
                                    707.0000000 647.00000 8.49% - 12s
                                    647.0000000 647.00000 0.00%
65
     H = 0
66
67
     Cutting planes:
68
       Gomory: 3
69
       Cover: 136
       Implied bound: 504
70
       Clique: 3
       MIR: 18
73
       StrongCG: 25
74
       GUB cover: 6
75
       RLT: 14
76
       Relax-and-lift: 2
     Explored 1 nodes (9739 simplex iterations) in 12.79 seconds (20.47 work units)
     Thread count was 8 (of 8 available processors)
```

```
80
 81
    Solution count 7: 647 707 727 ... 1527
 82
 83 Optimal solution found (tolerance 1.00e-10)
    Best objective 6.470000000000e+02, best bound 6.47000000000e+02, gap 0.0000%
    Set parameter MIPGap to value 1e-08
 85
 86 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
 87
    CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
 88
    Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
 89
 90
 91
    Optimize a model with 2481684 rows, 1955335 columns and 17236273 nonzeros
 92
    Model fingerprint: 0xdd2ae776
    Variable types: 963295 continuous, 992040 integer (985965 binary)
 93
 94 Coefficient statistics:
     Matrix range [1e-01, 1e+10]
 96
     Objective range [6e-05, 5e+01]
     Bounds range [1e+00, 8e+01]
 97
 98
     RHS range
                    [8e-01, 1e+10]
     Warning: Model contains large matrix coefficients
100 Warning: Model contains large rhs
101
          Consider reformulating model or setting NumericFocus parameter
         to avoid numerical issues.
102
103 Presolve removed 2478686 rows and 1954269 columns (presolve time = 5s) ...
104 Presolve removed 2478686 rows and 1954269 columns
105 Presolve time: 5.07s
106 Presolved: 2998 rows, 1066 columns, 7940 nonzeros
107
    Variable types: 8 continuous, 1058 integer (626 binary)
108 Found heuristic solution: objective 3251.8528892
109 Found heuristic solution: objective 3465.7100450
110
111 Root simplex log...
112
113 Iteration Objective
                          Primal Inf. Dual Inf.
        0 7.7662796e+03 5.820592e+03 0.000000e+00
114
       1040 4.3839422e+03 0.000000e+00 0.000000e+00
115
116
117 Root relaxation: objective 4.383942e+03, 1040 iterations, 0.02 seconds (0.01 work units)
118
119
      Nodes | Current Node | Objective Bounds
                                                      Work
    Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
120
121
       0 \quad 0.4383.94217 \quad 0 \quad 22.3465.71005.4383.94217.26.5\%
122
123 H 0 0
                        4358.0671749 4383.94217 0.59% - 6s
                        4378.0671749 4383.94217 0.13%
124 H 0
       0 0 4383.17520 0 18 4378.06717 4383.17520 0.12% - 6s
125
       0 0 4383.17520 0 14 4378.06717 4383.17520 0.12% -
126
                                                                  6s
127
       0 0 4383.17520 0 9 4378.06717 4383.17520 0.12% -
128 H 0 0
                        4381.8528892 4383.17520 0.03%
129
130 Cutting planes:
131 Learned: 2
132
     MIR: 2
133
134 Explored 1 nodes (1936 simplex iterations) in 6.75 seconds (7.57 work units)
135 Thread count was 8 (of 8 available processors)
136
137 Solution count 5: 4381.85 4378.07 4358.07 ... 3251.85
138
139 Optimal solution found (tolerance 1.00e-08)
140 Best objective 4.381852889165e+03, best bound 4.381852889165e+03, gap 0.0000%
141 SP is solved
142 SP's optimal solution is' □4381
143
144
     Itr = 0
145 Collect_LB = [647.0]
146 Collect_UB = [9410.70577833071]
147 Collect Hua = [0.0]
148 Collect SPObjVal = [4381.852889165355]
149 Collect_MPObjValNHua = [647.0]
150
151
152
    Set parameter MIPGap to value 0.05
153 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
154
155 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
156 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
157
158 Optimize a model with 1140514 rows, 303661 columns and 3363968 nonzeros
159 Model fingerprint: 0x4fad03a4
160 Variable types: 1 continuous, 303660 integer (292257 binary)
161 Coefficient statistics:
162
     Matrix range [1e-01, 1e+10]
     Objective range [1e+00, 2e+01]
163
```

```
Bounds range
164
                    [1e+00, 1e+00]
165
      RHS range
                    [1e+00, 2e+10]
    Warning: Model contains large matrix coefficients
166
167
    Warning: Model contains large rhs
         Consider reformulating model or setting NumericFocus parameter
168
169
         to avoid numerical issues.
170 Presolve removed 887295 rows and 275736 columns (presolve time = 5s) ...
171 Presolve removed 909924 rows and 277610 columns (presolve time = 10s) ...
172 Presolve removed 909924 rows and 277610 columns (presolve time = 15s) ...
173 Presolve removed 1010309 rows and 287903 columns
174 Presolve time: 17.29s
175 Presolved: 130205 rows, 15758 columns, 395077 nonzeros
176
    Variable types: 1 continuous, 15757 integer (13150 binary)
177
178 Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
    Showing first log only...
180
181 Root relaxation presolved: 15758 rows, 145963 columns, 410835 nonzeros
182
183
184 Root simplex log...
185
                          Primal Inf. Dual Inf.
186 Iteration Objective
187
        0 5.0288529e+03 0.000000e+00 8.172938e+03
188 Concurrent spin time: 0.28s
189
190 Solved with dual simplex (primal model)
191
    Root relaxation: objective 5.028853e+03, 8662 iterations, 1.97 seconds (3.15 work units)
192
193 Total elapsed time = 23.23s
194 Total elapsed time = 25.36s
195
196
       Nodes | Current Node
                                  Objective Bounds
                                                     | Work
197
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
198
199
           0.5028.85289 0.258
                                     - 5028.85289
                                                         26s
200
       0
           0 5028.85289 0 746
                                    - 5028.85289
201
           0 5028.85289 0 720
                                    - 5028.85289
                                                       - 31s
202
           0.5028.85289 0.727
                                    - 5028.85289
       0
                                                       - 32s
203
       0
           0 5028.85289 0 723
                                    - 5028.85289
                                                       - 33s
204
           0 5028.85289
                         0 698
                                    - 5028.85289
205
       0
           0 5028.85289
                         0 217
                                    - 5028.85289
                                                       - 45s
                                                       - 45s
206
           0.5028.85289 0.237
                                    - 5028.85289
       0
207
       0
           0 5028.85289
                         0 276
                                    - 5028.85289
                                                       - 46s
       0
           0 5028.85289
                                                       - 46s
208
                         0 275
                                     - 5028.85289
                                    - 5028.85289
                                                       - 53s
209
       0
           0.5028.85289 0.190
                                                       - 54s
210
           0 5028.85289 0 218
                                    - 5028.85289
211
       0
           0 5028.85289
                         0 184
                                    - 5028.85289
                                                         58s
212
           0 5028.85289 0 186
                                    - 5028.85289
       0
           0 5028.85289 0 304
                                    - 5028.85289
213
       0
                                                       - 68s
214
       0
           0 5028.85289 0 327
                                    - 5028.85289
                                                       - 68s
215
           0 5028.85289
                                    - 5028.85289
                         0 316
           0 5028.85289 0 317
                                    - 5028.85289
                                                       - 69s
216
       0
                                                       - 77s
                                    - 5028.85289
217
       0
           0.5028.85289 0.318
218
       0
           0 5028.85289 0 316
                                    - 5028.85289
                                                       - 78s
219
       0
           0 5028.85289 0 316
                                    - 5028.85289
                                                         78s
220
       0
           0 5028.85289 0 292
                                    - 5028.85289
221 H 0 0
                        5028.8528892 5028.85289 0.00%
                                                         - 91s
222
          223
224 Cutting planes:
225
      Gomory: 1
      Cover: 210
226
227
      Implied bound: 57
228
      Clique: 1050
229
      MIR: 475
230
      StrongCG: 81
231
      Flow cover: 11
232
      GUB cover: 26
233
      Zero half: 27
234
      RLT: 60
      Relax-and-lift: 357
235
236
      BQP: 47
238 Explored 1 nodes (186645 simplex iterations) in 91.36 seconds (267.10 work units)
239 Thread count was 8 (of 8 available processors)
240
241 Solution count 1: 5028.85
242
243 Optimal solution found (tolerance 5.00e-02)
244 Best objective 5.028852889165e+03, best bound 5.028852889165e+03, gap 0.0000%
245 Set parameter MIPGap to value 1e-08
246 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
247
```

```
248 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
249 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
250
251 Optimize a model with 2481684 rows, 1955335 columns and 17236273 nonzeros
252 Model fingerprint: 0xb66ebb75
253 Variable types: 963295 continuous, 992040 integer (985965 binary)
254 Coefficient statistics:
255 Matrix range [1e-01, 1e+10]
     Objective range [6e-05, 5e+01]
256
     Bounds range [1e+00, 8e+01]
257
258
                    [8e-01, 1e+10]
     RHS range
259 Warning: Model contains large matrix coefficients
260 Warning: Model contains large rhs
          Consider reformulating model or setting NumericFocus parameter
261
262
          to avoid numerical issues.
263 Presolve removed 2477274 rows and 1953860 columns
264 Presolve time: 4.77s
265 Presolved: 4410 rows, 1475 columns, 11768 nonzeros
266 Variable types: 8 continuous, 1467 integer (850 binary)
267 Found heuristic solution: objective 3227.8528892
268
269 Root simplex log...
270
271 Iteration Objective
                           Primal Inf. Dual Inf.
        0 9.0534085e+03 3.964725e+03 0.000000e+00
272
273
       1268 4.7955672e+03 0.000000e+00 0.000000e+00
274
275 Root relaxation: objective 4.795567e+03, 1268 iterations, 0.01 seconds (0.01 work units)
276
277
       Nodes | Current Node | Objective Bounds
                                                       Work
278 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
279
280 H 0 0
                         4795.5671749 13146.7410 174% - 6s
                  - 0
                         4795.56717 4795.56717 0.00% - 6s
281
282
283 Explored 1 nodes (1906 simplex iterations) in 6.35 seconds (6.97 work units)
284 Thread count was 8 (of 8 available processors)
285
286 Solution count 2: 4795.57 3227.85
287
288 Optimal solution found (tolerance 1.00e-08)
289 Best objective 4.795567174880e+03, best bound 4.795567174880e+03, gap 0.0000%
290 SP is solved
291 SP's optimal solution is' □4795
292
293
294 Collect_LB = [647.0, 5028.852889165355]
295 Collect_UB = [9410.70577833071, 5442.567174879641]
296 Collect Hua = [0.0, 4381.852889165355]
297 Collect SPObjVal = [4381.852889165355, 4795.567174879641]
298 Collect MPObjValNHua = [647.0, 647.0]
299
300
301 Set parameter MIPGap to value 0.05
302 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
304 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
305 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
306
307 Optimize a model with 1676770 rows, 323344 columns and 5062590 nonzeros
308 Model fingerprint: 0xd1f3e031
309 Variable types: 1 continuous, 323343 integer (300573 binary)
310 Coefficient statistics:
     Matrix range [1e-01, 1e+10]
311
     Objective range [1e+00, 2e+01]
312
313 Bounds range [1e+00, 1e+00]
314
     RHS range
                    [1e+00, 2e+10]
315 Warning: Model contains large matrix coefficients
316 Warning: Model contains large rhs
          Consider reformulating model or setting NumericFocus parameter
317
          to avoid numerical issues.
318
319 Presolve removed 1346036 rows and 288770 columns (presolve time = 5s) ...
320 Presolve removed 1380501 rows and 291938 columns (presolve time = 10s) ...
321 Presolve removed 1394517 rows and 292727 columns (presolve time = 18s) ...
322 Presolve removed 1456034 rows and 301032 columns (presolve time = 20s) ...
323 Presolve removed 1474511 rows and 301032 columns
324 Presolve time: 20.62s
325 Presolved: 202259 rows, 22312 columns, 647473 nonzeros
326 Variable types: 1 continuous, 22311 integer (17164 binary)
327
328 Deterministic concurrent LP optimizer: primal simplex, dual simplex, and barrier
329 Showing barrier log only...
330
    Root relaxation presolved: 22312 rows, 224571 columns, 669785 nonzeros
331
```

```
332
333 Root barrier log...
334
335 Ordering time: 2.56s
336
337 Barrier statistics:
338 Dense cols: 29
339 Free vars: 748
340
     AA' NZ : 7.020e+05
Factor NZ: 2.218e+07 (roughly 300 MB of memory)
342
    Factor Ops: 5.538e+10 (roughly 2 seconds per iteration)
343
     Threads: 1
344
345
                               Residual
              Objective
346 Iter
           Primal
                      Dual
                                Primal Dual Compl Time
347
      0 -5.64830474e+07 3.34809857e+04 2.69e+04 1.97e+03 9.11e+04 26s
348
349 Barrier performed 0 iterations in 26.07 seconds (49.16 work units)
350 Barrier solve interrupted - model solved by another algorithm
351
352 Concurrent spin time: 0.97s (can be avoided by choosing Method=3)
353
354 Solved with primal simplex
355
Root relaxation: objective 5.456853e+03, 22745 iterations, 4.53 seconds (6.36 work units)
357
    Total elapsed time = 30.08s
    Total elapsed time = 35.88s
358
359
360
       Nodes | Current Node | Objective Bounds
                                                        Work
361
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
362
           0.5456.85289 0.548
                                    - 5456.85289
363
                                                  - - 38s
364
           0 5456.85289 0 690
                                    - 5456.85289
                                                      - 38s
365
       0
           0 5456.85289
                         0 914
                                    - 5456.85289
                                                      - 49s
366
           0 5456.85289 0 923
                                    - 5456.85289
                                                      - 49s
       0
                                                      - 55s
367
           0.5456.85289
                         0.911
                                    - 5456.85289
368
       0
           0 5456.85289
                         0 912
                                    - 5456.85289
                                                      - 55s
                                                      - 72s
369
           0 5456.85289 0 673
                                    - 5456.85289
370
       0
           0.5456.85289
                                    - 5456.85289
                                                      - 72s
                         0 666
371
       0
           0 5456.85289
                         0 783
                                    - 5456.85289
                                                      - 76s
           0 5456.85289
                         0 785
                                    - 5456.85289
372
373
       0
           0 5456.85289
                         0 450
                                    - 5456.85289
                                                      - 95s
                                                      - 96s
                                    - 5456.85289
374
           0.5456.85289 0.462
       0
375
       0
           0 5456.85289
                         0 462
                                    - 5456.85289
                                                      - 96s
       0
                                                      - 97s
376
           0 5456.85289
                         0 423
                                    - 5456.85289
                                                  - - 98s
377
       0
           0 5456.85289 0 405
                                    - 5456.85289
378
           0 5456.85289
                         0 377
                                    - 5456.85289
                                                      - 113s
379
       0
           0 5456.85289
                         0 487
                                    - 5456.85289
                                                      - 114s
380
           0 5456.85289
                         0 484
                                    - 5456.85289
                                                      - 114s
       0
381
       0
           0.5456.85289
                         0 459
                                    - 5456.85289
                                                      - 116s
382
       0
           0 5456.85289 0 491
                                    - 5456.85289
                                                      - 116s
           0 5456.85289
                         0 489
383
                                    - 5456.85289
                                                     - 117s
384
           0 5456.85289
       0
                         0 316
                                    - 5456.85289
                                                      - 128s
                                                      - 128s
385
       0
           0.5456.85289 0.323
                                    - 5456.85289
386
           0 5456.85289
                         0 307
                                    - 5456.85289
                                                      - 129s
387
       0
           0 5456.85289
                         0 377
                                    - 5456.85289
                                                      - 130s
                                                  - - 130s
388
       0
           0 5456.85289 0 379
                                    - 5456.85289
389
       0
           0 5456.85289
                         0 374
                                    - 5456.85289
                                                      - 141s
390
       0
           0 5456.85289
                         0 388
                                    - 5456.85289
                                                      - 142s
391
           0 5456.85289 0 388
                                    - 5456.85289
                                                   - - 142s
       0
392
       0 \quad 0 \ 5456.85289 \quad 0 \ 274
                                    - 5456.85289
                                                   - - 145s
393 H 0 0
                       5456.8528892 5456.85289 0.00% - 167s
          0 5456.85289 0 274 5456.85289 5456.85289 0.00% - 167s
394
395
396 Cutting planes:
397
     Learned: 15
398
     Gomory: 3
399
     Cover: 330
400
     Implied bound: 102
401
      Clique: 3890
402
     MIR: 462
      StrongCG: 260
403
404
     Flow cover: 26
405
      GUB cover: 69
406
     Zero half: 24
407
      Network: 3
408
     RLT: 141
409
     Relax-and-lift: 463
410
     BOP: 51
411
     PSD: 3
412
413 Explored 1 nodes (266619 simplex iterations) in 167.41 seconds (527.99 work units)
414 Thread count was 8 (of 8 available processors)
415
```

```
416 Solution count 1: 5456.85
417
418 Optimal solution found (tolerance 5.00e-02)
419 Best objective 5.456852889165e+03, best bound 5.456852889165e+03, gap 0.0000%
    Warning: linear constraint 604259 and linear constraint 1140515 have the same name "ConSP25 1[0,0]"
     Set parameter MIPGap to value 1e-08
421
    Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
422
423
424 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
425 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
426
427 Optimize a model with 2481684 rows, 1955335 columns and 17236273 nonzeros
428 Model fingerprint: 0x622fa79d
429 Variable types: 963295 continuous, 992040 integer (985965 binary)
430 Coefficient statistics:
431
      Matrix range [1e-01, 1e+10]
      Objective range [6e-05, 5e+01]
432
433
      Bounds range
                     [1e+00, 8e+01]
434
                     [8e-01, 1e+10]
      RHS range
435
     Warning: Model contains large matrix coefficients
436 Warning: Model contains large rhs
437
          Consider reformulating model or setting NumericFocus parameter
438
          to avoid numerical issues.
439 Presolve removed 2477413 rows and 1953880 columns
440 Presolve time: 4.80s
441 Presolved: 4271 rows, 1455 columns, 11395 nonzeros
442 Variable types: 8 continuous, 1447 integer (841 binary)
443 Found heuristic solution: objective 3253.5671749
444
445 Root simplex log...
446
447 Iteration Objective
                            Primal Inf. Dual Inf.
                                                    Time
448
         0 9.2334085e+03 4.138363e+03 0.000000e+00
449
       1264 4.8105672e+03 0.000000e+00 0.000000e+00
450
451 Root relaxation: objective 4.810567e+03, 1264 iterations, 0.02 seconds (0.01 work units)
452
453
       Nodes | Current Node | Objective Bounds
454
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
455
456 H 0 0
                          4810.5671749 12966.7410 170% - 6s
457
           0
                   - 0
                          4810.56717 4810.56717 0.00% - 6s
        0
458
459 Explored 1 nodes (1895 simplex iterations) in 6.35 seconds (6.95 work units)
460 Thread count was 8 (of 8 available processors)
461
462 Solution count 2: 4810.57 3253.57
463
464 Optimal solution found (tolerance 1.00e-08)
465 Best objective 4.810567174880e+03, best bound 4.810567174880e+03, gap 0.0000%
466
    SP is solved
467 SP's optimal solution is' □ 4810
468
469
      Itr = 2
470 Collect LB = [647.0, 5028.852889165355, 5456.852889165355]
471 Collect UB = [9410.70577833071, 5442.567174879641, 5442.567174879641]
472 Collect Hua = [0.0, 4381.852889165355, 4795.567174879641]
473 Collect_SPObjVal = [4381.852889165355, 4795.567174879641, 4810.567174879641]
474 Collect_MPObjValNHua = [647.0, 647.0, 661.2857142857138]
475
476
477
      Reach the termination conditions, stop iteration
478
     Values adopted from the judgeCount's th iteration, and Itr = \{2\}, judgeCount = \{1\}
479
                 -judgeCount = 1, SPObj_SPF = 4795.567174879641
480
                  pi: 0-5, ai-di: 8-25, gi_SP-gpi_SP: 0.000000-0.000000,
                                                                               ai_SP-di: 8-25, taoi-deltai: 8-17, taoPi_SP-deltaPi_SP: 8-17,
481
    Vessel i: 0:
                                                                                                                                                betaNi: 9,
     bi: 9
482
    Vessel i: 1:
                   pi: 5-10, ai-di: 3-21, gi SP-gpi SP: 0.0000000-0.000000,
                                                                                ai SP-di: 3-21, taoi-deltai: 3-15, taoPi SP-deltaPi SP: 3-15, betaNi: 12
         bi: 12
     Vessel i: 2:
                                             gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                                                         taoPi_SP-deltaPi_SP: 13-28,
                   pi: 18-23,
                               ai-di: 13-36,
                                                                                  ai_SP-di: 13-36,
                                                                                                     taoi-deltai: 13-28,
     betaNi: 15.
                  bi: 15
     Vessel i: 3:
                   pi: 9-15,
                              ai-di: 22-49,
                                             gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                 ai_SP-di: 22-49,
                                                                                                    taoi-deltai: 22-39,
                                                                                                                        taoPi_SP-deltaPi_SP: 22-39,
                                                                                                                                                     betaNi
           bi: 17
      17,
     Vessel i: 4:
                   pi: 22-28,
                               ai-di: 35-57,
                                             gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                  ai SP-di: 35-57,
                                                                                                     taoi-deltai: 35-48,
                                                                                                                         taoPi SP-deltaPi SP: 35-48,
     betaNi: 13
                  bi: 13
486
     Vessel i: 5:
                   pi: 11-18,
                               ai-di: 3-35,
                                             gi SP-gpi SP: 0.257143-0.800000,
                                                                                 ai SP-di: 4-35,
                                                                                                  taoi-deltai: 6-21,
                                                                                                                     taoPi SP-deltaPi SP: 6-21, betaNi: 15
         bi: 15
     Vessel i: 6:
                  pi: 29-34,
                               ai-di: 2-29.
                                             gi_SP-gpi_SP: 1.000000-0.000000,
                                                                                 ai SP-di: 10-29,
                                                                                                    taoi-deltai: 7-15.
                                                                                                                      taoPi_SP-deltaPi_SP: 10-15, betaNi:
         hi· 8
488
     Vessel i: 7:
                   pi: 15-22,
                               ai-di: 27-68,
                                              gi SP-gpi SP: 1.000000-0.600000,
                                                                                  ai SP-di: 37-68,
                                                                                                     taoi-deltai: 37-53,
                                                                                                                         taoPi SP-deltaPi SP: 37-53,
     betaNi: 16,
                  bi: 16
                  pi: 28-34,
                               ai-di: 29-59.
                                             gi SP-gpi SP: 0.142857-1.000000,
                                                                                  ai SP-di: 30-59.
                                                                                                     taoi-deltai: 30-35.
                                                                                                                         taoPi SP-deltaPi SP: 30-35,
     Vessel i: 8:
     betaNi: 5,
                 bi: 5
490
```

```
unknown
unknown

491 round LB = [647, 5029, 5457]

492 round UB = [9411, 5443, 5443]

493 round Hua = [0, 4382, 4796]

494 round SPObjVal = [4382, 4796, 4811]

495 round MPObjValNHua = [647, 647, 661]

496

497 Time: 739.000000

498

499

500

501
```