```
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=41288
     import sys; print('Python %s on %s' % (sys.version, sys.platform))
 4
     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 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 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 543655 rows, 46641 columns and 1499735 nonzeros
19
     Model fingerprint: 0x93443863
     Variable types: 1 continuous, 46640 integer (46608 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.
     Presolve removed 364125 rows and 24742 columns (presolve time = 5s) ...
30
31
     Presolve removed 488817 rows and 33971 columns
     Presolve time: 6.41s
     Presolved: 54838 rows, 12670 columns, 188803 nonzeros
34
     Variable types: 0 continuous, 12670 integer (12646 binary)
35
     Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
     Showing first log only...
37
38
39
     Root relaxation presolved: 54833 rows, 12675 columns, 188788 nonzeros
40
41
42
     Root simplex log...
43
44
                                    Primal Inf. Dual Inf.
     Iteration Objective
           0 9.1900000e+02 8.650000e+01 1.965148e+08
45
46
     Concurrent spin time: 0.02s
48
     Solved with dual simplex (primal model)
49
50
     Root relaxation: objective 7.790000e+02, 2314 iterations, 0.24 seconds (0.22 work units)
51
        Nodes | Current Node | Objective Bounds
52
                                                                               Work
53
      Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
54
55
              0 779.00000 0 40
                                                 - 779.00000
                                 5139.0000000 779.00000 84.8%
56
    H = 0 = 0
57
     Н
          0
                                 4979.0000000 779.00000 84.4%
                                 2479.0000000 779.00000 68.6%
58
    Η
59
              0 779.00000 0 195 2479.00000 779.00000 68.6%
         0
                                                                                           8s
              0\ 779.00000\ 0\ 89\ 2479.00000\ 779.00000\ 68.6\%
60
         0
61 H 0
                                 2359.0000000 779.00000 67.0%
                                 2139.0000000 779.00000 63.6%
62
     H = 0
63
                                 1479 0000000 779 00000 47 3%
    Н
         0
               0
64
         0
             0 779.00000 0 90 1479.00000 779.00000 47.3%
                                 1439.0000000 779.00000 45.9%
65
     H = 0
              0 779.00000 0 10 1439.00000 779.00000 45.9%
66
67
         0
              0 779.00000 0 18 1439.00000 779.00000 45.9%
                                                                                     - 10s
68
              0 779.00000 0 18 1439.00000 779.00000 45.9%
                                                                                          10s
              0 779.00000 0 36 1439.00000 779.00000 45.9%
69
                                                                                      - 11s
              0 779 00000 0 64 1439 00000 779 00000 45 9%
70
         0
                                                                                     - 11s
         0
              0 779.00000 0 53 1439.00000 779.00000 45.9%
                                                                                      - 11s
    H 0
                                  779.0000000 779.00000 0.00%
73
             0 779.00000 0 22 779.00000 779.00000 0.00%
74
     Cutting planes:
75
76
       Gomory: 2
       Cover: 275
77
78
       Implied bound: 882
79
       Clique: 19
```

```
MIR: 49
 80
 81
      StrongCG: 27
      GUB cover: 8
 82
 83
      Zero half: 2
      RLT: 17
 85
      Relax-and-lift: 18
      BQP: 9
 86
 87
      PSD: 1
 88
 89 Explored 1 nodes (25963 simplex iterations) in 12.42 seconds (21.52 work units)
 90 Thread count was 8 (of 8 available processors)
    Solution count 8: 779 1439 1479 ... 5139
 93
 94 Optimal solution found (tolerance 1.00e-10)
    Best objective 7.790000000000e+02, best bound 7.79000000000e+02, gap 0.0000%
     Set parameter MIPGap to value 1e-08
 97
     Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
 98
 99 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
100 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
101
     Optimize a model with 1983368 rows, 1559473 columns and 13693931 nonzeros
102
103 Model fingerprint: 0x1ad678e8
104 Variable types: 766961 continuous, 792512 integer (787112 binary)
105 Coefficient statistics:
106 Matrix range [1e-01, 1e+10]
     Objective range [6e-05, 5e+01]
107
     Bounds range [1e+00, 8e+01]
108
109
     RHS range
                   [8e-01, 1e+10]
110 Warning: Model contains large matrix coefficients
111 Warning: Model contains large rhs
112
          Consider reformulating model or setting NumericFocus parameter
113
          to avoid numerical issues.
114 Presolve removed 1981092 rows and 1558646 columns
115 Presolve time: 3.97s
116 Presolved: 2276 rows, 827 columns, 6068 nonzeros
117 Variable types: 6 continuous, 821 integer (486 binary)
118 Found heuristic solution: objective 3611.0215813
119
120 Root simplex log...
121
                          Primal Inf. Dual Inf.
122 Iteration Objective
123
        0 7.6070000e+03 2.825420e+03 0.000000e+00
124
       637 5.0405771e+03 0.000000e+00 0.000000e+00
125
126 Root relaxation: objective 5.040577e+03, 637 iterations, 0.00 seconds (0.00 work units)
127
128
       Nodes | Current Node | Objective Bounds
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
129
130
           131
132 H 0 0
                         4980.5771368 5040.57714 1.20% - 5s
                         5010.5771368 5040.57714 0.60%
133 H 0 0
                                                             5s
134 H 0 0
                         5028.5771368 5040.57714 0.24%
135
        0
                     0 5040.5771368 5040.57714 0.00%
136
137 Cutting planes:
138
     Gomory: 1
139
      Cover: 4
     Implied bound: 1
140
141
      Clique: 9
     MIR: 1
142
143
     Zero half: 3
144
      RLT: 2
145
      Relax-and-lift: 2
146
147 Explored 1 nodes (982 simplex iterations) in 5.28 seconds (5.87 work units)
148 Thread count was 8 (of 8 available processors)
149
150 Solution count 5: 5040.58 5028.58 5010.58 ... 3611.02
151
152 Optimal solution found (tolerance 1.00e-08)
153 Best objective 5.040577136846e+03, best bound 5.040577136846e+03, gap 0.0000%
154 SP is solved
155 SP's optimal solution is' □ 5040
156
157
     Itr = 0
158 Collect LB = [779.0]
159 Collect_UB = [10860.154273692304]
160 Collect_Hua = [0.0]
161 Collect_SPObjVal = [5040.577136846152]
162 Collect_MPObjValNHua = [779.0]
163
```

```
164
165 Set parameter MIPGap to value 0.05
166 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
167
    CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
169 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
170
171 Optimize a model with 978249 rows, 246921 columns and 2874075 nonzeros
172
    Model fingerprint: 0x6669dd3c
173 Variable types: 1 continuous, 246920 integer (236784 binary)
174 Coefficient statistics:
175
      Matrix range [1e-01, 1e+10]
176
      Objective range [1e+00, 2e+01]
177
      Bounds range [1e+00, 1e+00]
178
      RHS range
                   [1e+00, 2e+10]
    Warning: Model contains large matrix coefficients
179
180 Warning: Model contains large rhs
181
          Consider reformulating model or setting NumericFocus parameter
182
         to avoid numerical issues.
183 Presolve removed 814101 rows and 226888 columns (presolve time = 5s) ...
184 Presolve removed 888229 rows and 235283 columns (presolve time = 10s) ...
185 Presolve removed 901510 rows and 235288 columns
    Presolve time: 10.72s
187 Presolved: 76739 rows, 11633 columns, 238449 nonzeros
188
    Variable types: 1 continuous, 11632 integer (9629 binary)
189
190 Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
191 Showing first log only...
192
193 Root relaxation presolved: 11633 rows, 88372 columns, 250082 nonzeros
194
195
196 Root simplex log...
197
198 Iteration Objective
                          Primal Inf. Dual Inf.
                                                 Time
        0 5.8395771e+03 0.000000e+00 1.706797e+04
199
200 Concurrent spin time: 0.40s
201
202 Solved with dual simplex (primal model)
203
204 Root relaxation: objective 5.839577e+03, 5949 iterations, 1.30 seconds (1.91 work units)
205
206
       Nodes | Current Node | Objective Bounds
                                                        Work
207
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
208
                                    - 5839.57714
209
          0 5839.57714 0 235
210
           0.5839.57714 0.659
                                    - 5839.57714
                                                      - 15s
211
       0
           0 5839.57714
                         0 601
                                    - 5839.57714
                                                       - 16s
212
           0 5839.57714
                         0 482
                                    - 5839.57714
                                                       - 16s
           0 5839.57714
                                    - 5839.57714
213
       0
                         0 479
                                                       - 16s
214
       0
           0 5839.57714
                         0 124
                                    - 5839.57714
                                                      - 20s
           0 5839.57714
                         0 293
                                    - 5839.57714
215
           0 5839.57714 0 314
                                    - 5839.57714
216
       0
                                                       - 21s
                                                       - 25s
217
       0
           0.5839.57714
                         0 159
                                    - 5839.57714
218
           0 5839.57714 0 129
                                    - 5839.57714
                                                       - 26s
219
       0
           0 5839.57714 0 126
                                    - 5839.57714
                                                         26s
220
       0
           0 5839.57714 0 153
                                    - 5839.57714
221
           0 5839.57714
                         0 115
                                    - 5839.57714
                                                         29s
222
           0 5839.57714
                         0 269
                                    - 5839.57714
                                                         29s
223
           0 5839.57714 0 117
                                    - 5839.57714
                                                       - 31s
       0
224
                                    - 5839 57714
       0
           0 5839.57714
                         0 100
                                                       - 31s
225
       0
           0 5839.57714
                         0 233
                                    - 5839.57714
                                                       - 32s
226
           0 5839.57714
                         0 126
                                    - 5839.57714
227
           0 5839.57714 0 246
                                    - 5839.57714
                                                       - 34s
       0
228
                                                      - 34s
       0
           0 5839.57714 0 241
                                    - 5839.57714
229
           0.5839.57714 \quad 0.63
                                    - 5839.57714
                                                  - - 35s
230
       0
           0 5839.57714 0 70
                                    - 5839.57714
                                                      - 35s
231
           0.5839.57714 0.131
                                    - 5839 57714
                                                   - - 36s
       0
232
           0 5839.57714 0 67
                                    - 5839.57714
                                                   - - 37s
233
           2\ 5839.57714\quad 0\quad 67
                                    - 5839.57714
                                                      - 40s
234
       19
           22 6008.46603 5 389
                                     - 5839.57714 - 1744 45s
       41 41 6039.57714 11 146
235
                                      - 5839 57714
                                                     - 1615 50s
236
       61
           60 6039.57714 17 168
                                      - 5839.57714
                                                     - 1471
237
      112 117 6039.57714 26 310
                                       - 5839.57714
                                                     - 1064 60s
238
      223 224 6039 57714 34 306
                                                      - 696 66s
                                       - 5839 57714
239
      340 314 6039.57714 54 276
                                       - 5839.57714
                                                      - 512
                                                              70s
240
      686 705 6039.57714 94 197
                                       - 5839.57714
                                                      - 294 76s
                                                      - 228 80s
241
      967 850 6039.57714 137 238
                                        - 5839.57714
                                                       - 226 86s
      1163 1106 6039.57714 172 254
242
                                         - 5839 57714
243 * 1470 499
                       80 5839.5771368 5839.57714 0.00% 200 89s
244
245 Cutting planes:
246
     Learned: 15
247
      Gomory: 2
```

```
unknown
248
      Cover: 519
249
      Implied bound: 441
250
      Clique: 123
251
      MIR: 102
252
      StrongCG: 49
253
      Flow cover: 11
      GUB cover: 307
254
255
      Zero half: 22
256
      RLT: 78
257
      Relax-and-lift: 232
258
      BQP: 17
259
260 Explored 1694 nodes (432903 simplex iterations) in 89.69 seconds (218.45 work units)
261 Thread count was 8 (of 8 available processors)
262
263 Solution count 1: 5839.58
264
265 Optimal solution found (tolerance 5.00e-02)
266 Best objective 5.839577136846e+03, best bound 5.839577136846e+03, gap 0.0000%
267 Set parameter MIPGap to value 1e-08
268 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
269
270 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
271 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
272
273 Optimize a model with 1983368 rows, 1559473 columns and 13693931 nonzeros
274 Model fingerprint: 0x4b2e84e9
275 Variable types: 766961 continuous, 792512 integer (787112 binary)
276 Coefficient statistics:
277 Matrix range [1e-01, 1e+10]
278
      Objective range [6e-05, 5e+01]
279 Bounds range [1e+00, 8e+01]
280 RHS range
                    [8e-01, 1e+10]
     Warning: Model contains large matrix coefficients
281
282 Warning: Model contains large rhs
283
          Consider reformulating model or setting NumericFocus parameter
284
          to avoid numerical issues.
285 Presolve removed 1978553 rows and 1557793 columns
286 Presolve time: 3.84s
287 Presolved: 4815 rows, 1680 columns, 12856 nonzeros
288 Variable types: 6 continuous, 1674 integer (967 binary)
289 Found heuristic solution: objective 3627.0215813
290
291 Root relaxation: objective 5.338777e+03, 1290 iterations, 0.01 seconds (0.01 work units)
292
293
       Nodes | Current Node | Objective Bounds
                                                      | Work
294 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
295
296
        0 0 5338.77678 0 48 3627.02158 5338.77678 47.2% - 4s
297 H 0 0
                         5104.0843674 5338.77678 4.60% - 4s
298 H 0 0
                         5328.4064055 5338.77678 0.19%
299
        0 0 cutoff 0 5328.40641 5328.40641 0.00%
300
301 Cutting planes:
302
      Gomory: 2
303
      Cover: 1
304
      Clique: 9
305
      Zero half: 7
306
      RLT: 1
307
308 Explored 1 nodes (2068 simplex iterations) in 5.14 seconds (5.66 work units)
309 Thread count was 8 (of 8 available processors)
310
311 Solution count 3: 5328.41 5104.08 3627.02
312
313 Optimal solution found (tolerance 1.00e-08)
314 Best objective 5.328406405495e+03, best bound 5.328406405495e+03, gap 0.0000%
315 SP is solved
316 SP's optimal solution is' ☐ 5328
317
318 	 Itr = 1
319 Collect LB = [779.0, 5839.577136846152]
320 Collect_UB = [10860.154273692304, 6127.40640549518]
321 Collect Hua = [0.0, 5040.577136846152]
322 Collect SPObjVal = [5040.577136846152, 5328.40640549518]
323 Collect MPObjValNHua = [779.0, 799.0]
324
325
326 Set parameter MIPGap to value 0.05
327 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
328
329 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
330 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
331
```

```
332 Optimize a model with 1408285 rows, 264417 columns and 4243829 nonzeros
333 Model fingerprint: 0x3c12c4ec
334 Variable types: 1 continuous, 264416 integer (244176 binary)
335 Coefficient statistics:
336 Matrix range [1e-01, 1e+10]
337
      Objective range [1e+00, 2e+01]
     Bounds range [1e+00, 1e+00]
338
339
     RHS range
                   [1e+00, 2e+10]
340
    Warning: Model contains large matrix coefficients
341
    Warning: Model contains large rhs
342
          Consider reformulating model or setting NumericFocus parameter
343
         to avoid numerical issues.
344 Presolve removed 1198810 rows and 238844 columns (presolve time = 5s) ...
345 Presolve removed 1230112 rows and 241557 columns (presolve time = 10s) ...
346 Presolve removed 1295650 rows and 248172 columns (presolve time = 15s) ...
347 Presolve removed 1295686 rows and 248177 columns
348 Presolve time: 15.88s
349 Presolved: 112599 rows, 16240 columns, 370426 nonzeros
350 Variable types: 1 continuous, 16239 integer (12268 binary)
351
352 Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
353 Showing first log only...
354
355 Root relaxation presolved: 16240 rows, 128839 columns, 386666 nonzeros
356
357
358 Root simplex log...
359
                          Primal Inf. Dual Inf.
360 Iteration Objective
        0 6.1274064e+03 0.000000e+00 4.055143e+04
361
362
      15632 6.1274064e+03 0.000000e+00 0.000000e+00
      15632 6.1274064e+03 0.000000e+00 0.000000e+00
363
364 Concurrent spin time: 0.26s
365
366 Solved with primal simplex
367
Root relaxation: objective 6.127406e+03, 15632 iterations, 2.14 seconds (2.98 work units)
369 Total elapsed time = 20.56s
370
371
       Nodes | Current Node | Objective Bounds | Work
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
372
373
                                    - 6127 40641
374
           0.6127.40641 0.490
                                                  - - 26s
375
       0
           0 6127.40641 0 766
                                    - 6127.40641
376
       0
           0 6127.40641
                                    - 6127.40641
                         0 663
                                    - 6127.40641
                                                  - - 28s
377
       0
           0.6127.40641 0.746
           0.6127.40641 \quad 0.752
                                    - 6127.40641
378
                                                         28s
379
       0
           0 6127.40641
                         0 478
                                    - 6127.40641
                                                         37s
           0 6127.40641 0 510
380
                                    - 6127.40641
                                                       - 38s
       0
381
           0 6127.40641 0 200
                                    - 6127.40641
                                                      - 44s
       0
382
       0
           0 6127.40641
                         0 221
                                    - 6127.40641
                                                      - 44s
           0 6127.40641
                         0 265
                                    - 6127.40641
383
384
       0
           0 6127.40641 0 261
                                    - 6127.40641
                                                       - 52s
                                                      - 53s
385
           0.6127.40641 0.496
                                    - 6127.40641
       0
386
       0
           0 6127.40641 0 425
                                    - 6127.40641
                                                   - - 53s
       0
           0 6127.40641 0 229
                                                      - 59s
387
                                    - 6127.40641
                                                  - - 59s
388
       0
           0.6127.40641 0.202
                                    - 6127.40641
389
       0
           0.6127.40641 \quad 0.202
                                    - 6127.40641
                                                   - - 61s
                                                       - 72s
390
       0
           2\ 6127.40641\quad 0\ \ 202
                                    - 6127.40641
391
           8 6127.40641 2 490
                                    - 6127.40641
                                                   - 4980 76s
       3
392
           15 6127.40641 3 628
       11
                                     - 6127.40641
                                                   - 4053 80s
393
       23
           29 6127.40641 5 519
                                     - 6127.40641
                                                    - 3005 85s
394
          43 6127.40641 8 500
                                     - 6127.40641
       36
                                                    - 2271 92s
395
       43 68 6127.40641 11 288
                                      - 6127.40641
                                                     - 3141 100s
396
       71 125 6127.40641 23 319
                                      - 6127.40641
                                                     - 2830 113s
397
      149 272 6127.40641 67 132
                                       - 6127.40641
                                                    - 2090 132s
398
    * 231 272
                      141 6127.4064055 6127.40641 0.00% 1412 132s
399
400 Cutting planes:
     Learned: 29
401
402
      Gomory: 3
403
     Lift-and-project: 1
404
      Cover: 587
      Implied bound: 1348
405
406
      Clique: 3610
407
      MIR: 266
408
      StrongCG: 100
409
      Flow cover: 48
410
      GUB cover: 82
411
      Zero half: 44
      RLT: 112
412
      Relax-and-lift: 483
413
414
      BQP: 24
415
      PSD: 6
```

```
416
417 Explored 370 nodes (609654 simplex iterations) in 132.52 seconds (380.88 work units)
    Thread count was 8 (of 8 available processors)
418
419
420 Solution count 1: 6127.41
421
422 Optimal solution found (tolerance 5.00e-02)
423 Best objective 6.127406405495e+03, best bound 6.127406405495e+03, gap 0.0000%
    Warning: linear constraint 548214 and linear constraint 978250 have the same name "ConSP25 1[0,0]"
424
425 Set parameter MIPGap to value 1e-08
426 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
427
428 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
429 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
430
431 Optimize a model with 1983368 rows, 1559473 columns and 13693931 nonzeros
432 Model fingerprint: 0x464f5980
433 Variable types: 766961 continuous, 792512 integer (787112 binary)
434 Coefficient statistics:
435
      Matrix range [1e-01, 1e+10]
436
      Objective range [6e-05, 5e+01]
437
      Bounds range [1e+00, 8e+01]
                     [8e-01, 1e+10]
438
      RHS range
439
     Warning: Model contains large matrix coefficients
440 Warning: Model contains large rhs
441
          Consider reformulating model or setting NumericFocus parameter
442
          to avoid numerical issues.
443 Presolve removed 1978600 rows and 1557844 columns
444 Presolve time: 3.85s
445 Presolved: 4768 rows, 1629 columns, 12720 nonzeros
446 Variable types: 6 continuous, 1623 integer (941 binary)
447 Found heuristic solution: objective 3738.9989981
448
449 Root relaxation: objective 5.343111e+03, 1303 iterations, 0.02 seconds (0.01 work units)
450
       Nodes | Current Node | Objective Bounds
451

↓ Work

452
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
453
        0 0 5343.11111 0 8 3738.99900 5343.11111 42.9% - 4s
454
455 H 0 0
                         5343.1111111 5343.11111 0.00%
456
        0 0 5343.11111 0 8 5343.11111 5343.11111 0.00%
457
458 Explored 1 nodes (1836 simplex iterations) in 5.09 seconds (5.62 work units)
459 Thread count was 8 (of 8 available processors)
460
461 Solution count 2: 5343.11 3739
462
463 Optimal solution found (tolerance 1.00e-08)
464 Best objective 5.343111111111e+03, best bound 5.343111111111e+03, gap 0.0000%
465 SP is solved
466 SP's optimal solution is' □ 5343
467
468
     Itr = 2
469 Collect LB = [779.0, 5839.577136846152, 6127.40640549518]
470 Collect_UB = [10860.154273692304, 6127.40640549518, 6127.40640549518]
471 Collect Hua = [0.0, 5040.577136846152, 5328.40640549518]
472 Collect SPObjVal = [5040.577136846152, 5328.40640549518, 5343.11111111111]
473 Collect_MPObjValNHua = [779.0, 799.0, 799.0]
474
475
      Reach the termination conditions, stop iteration
476
477
      Values adopted from the Itr' th iteration, and Itr = \{2\}, judgeCount = \{2\}
478
479
     Values adopted from the judgeCount's th iteration, and Itr = \{2\}, judgeCount = \{2\}
480
481
     Values adopted from the judgeCount's th iteration, and Itr = \{2\}, judgeCount = \{1\}
482
                 -judgeCount = 1, SPObj SPF = 5328.40640549518
483
484 Vessel i: 0:
                  pi: 0-6,
                            ai-di: 1-20,
                                          gi_SP-gpi_SP: 0.000000-0.000000,
                                                                               ai SP-di: 1-20, taoi-deltai: 1-19, taoPi SP-deltaPi SP: 1-19, betaNi: 18
         bi: 18
485
     Vessel i: 1:
                  pi: 6-11, ai-di: 7-14,
                                           gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                ai SP-di: 7-14, taoi-deltai: 7-12,
                                                                                                                     taoPi_SP-deltaPi_SP: 7-12,
                                                                                                                                                 betaNi: 5
         bi: 5
     Vessel i: 2:
                   pi: 19-26,
                               ai-di: 4-30,
                                             gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                  ai_SP-di: 4-30,
                                                                                                   taoi-deltai: 4-28,
                                                                                                                     taoPi_SP-deltaPi_SP: 4-28,
                                                                                                                                                   betaNi: 24
         bi: 24
     Vessel i: 3:
                  pi: 11-17,
                               ai-di: 7-20,
                                             gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                  ai_SP-di: 7-20,
                                                                                                   taoi-deltai: 7-18,
                                                                                                                    taoPi_SP-deltaPi_SP: 7-18,
                                                                                                                                                   betaNi: 11
         bi: 11
     Vessel i: 4:
                  pi: 10-16,
                               ai-di: 31-44,
                                              gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                  ai_SP-di: 31-44,
                                                                                                     taoi-deltai: 31-42,
                                                                                                                         taoPi_SP-deltaPi_SP: 31-42,
     betaNi: 11.
                  bi: 11
                                              gi_SP-gpi_SP: 0.000000-0.527349,
                                                                                                     taoi-deltai: 21-27,
     Vessel i: 5:
                   pi: 10-15,
                               ai-di: 21-43,
                                                                                  ai_SP-di: 21-43,
                                                                                                                         taoPi_SP-deltaPi_SP: 21-27,
     betaNi: 6,
                 bi: 6
     Vessel i: 6:
                  pi: 10-17,
                               ai-di: 37-78,
                                              gi SP-gpi SP: 1.000000-0.600000,
                                                                                   ai SP-di: 45-78,
                                                                                                     taoi-deltai: 45-79,
                                                                                                                         taoPi SP-deltaPi SP: 45-79,
     betaNi: 34.
                  bi: 34
                   pi: 21-27,
     Vessel i: 7:
                               ai-di: 25-57,
                                              gi_SP-gpi_SP: 0.800000-0.672651,
                                                                                   ai_SP-di: 33-57,
                                                                                                     taoi-deltai: 33-46,
                                                                                                                         taoPi_SP-deltaPi_SP: 33-46,
     betaNi: 13,
                   bi: 13
```

unknown

```
492
492

493 round LB = [779, 5840, 6127]

494 round UB = [10860, 6127, 6127]

495 round Hua = [0, 5041, 5328]

496 round SPObjVal = [5041, 5328, 5343]

497 round MPObjValNHua = [779, 799, 799]

498

499 Time: 608.000000

500

501

502

503
```