```
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=39033
     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_BDC.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
     Optimize a model with 554430 rows, 52642 columns and 1554628 nonzeros
19
     Model fingerprint: 0xf37ad2f3
     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 330690 rows and 25098 columns (presolve time = 5s) ...
31
     Presolve removed 462236 rows and 35319 columns
     Presolve time: 9.05s
     Presolved: 92194 rows, 17323 columns, 283394 nonzeros
34
     Variable types: 0 continuous, 17323 integer (17301 binary)
35
     Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
     Showing first log only...
37
38
39
     Root relaxation presolved: 17323 rows, 109517 columns, 300717 nonzeros
40
41
42
     Root simplex log...
43
44
                                    Primal Inf. Dual Inf.
     Iteration Objective
          0 8.0300000e+02 0.000000e+00 1.021000e+03
45
                                                                               10s
46
     Concurrent spin time: 0.01s
48
     Solved with dual simplex (primal model)
49
50
     Root relaxation: objective 8.030000e+02, 2084 iterations, 0.42 seconds (0.36 work units)
51
     Total elapsed time = 10.06s
52
53
        Nodes | Current Node | Objective Bounds |
                                                                              Work
54
      Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
55
56
         0 0 803,00000 0 16
                                                - 803.00000
                                 3583.0000000 803.00000 77.6% - 10s
57
     H \quad 0 \quad 0
              0 803.00000 0 43 3583.00000 803.00000 77.6%
59 H 0 0
                                2123.0000000 803.00000 62.2% - 11s
60
              0 803.00000 0 176 2123.00000 803.00000 62.2%
              0 803.00000 0 168 2123.00000 803.00000 62.2%
62
         0
              0 803.00000 0 14 2123.00000 803.00000 62.2%
                                                                                    - 14s
              0\ 803.00000\ 0\ 14\ 2123.00000\ 803.00000\ 62.2\%
63
                                                                                    - 14s
         0
64
         0
              0 803.00000 0 32 2123.00000 803.00000 62.2%
         0
65
     Η
                                 1003.0000000 803.00000 19.9%
              0 803.00000 0 28 1003.00000 803.00000 19.9%
         0
66
67
         0
              0 803.00000 0 27 1003.00000 803.00000 19.9%
                                                                                     - 16s
68
              0 803.00000 0 14 1003.00000 803.00000 19.9%
         0
69
              0 803.00000 0 85 1003.00000 803.00000 19.9%
                                                                                     - 17s
70
              0.803.00000 0.74.1003.00000.803.00000.19.9%
         0
                                                                                     - 17s
                                                                                     - 18s
71
         0
              0 803.00000 0 16 1003.00000 803.00000 19.9%
              0 803.00000
                                 0 16 1003.00000 803.00000 19.9%
73
         0
              0 803.00000 0 7 1003.00000 803.00000 19.9%
                                                                                       25s
              0 803.00000 0 63 1003.00000 803.00000 19.9%
74
        0
                                                                                        26s
75
    H = 0
               0
                                  803.0000000 803.00000 0.00%
76
         0 \quad 0 \ 803.00000 \quad 0 \ 88 \ 803.00000 \ 803.00000 \ 0.00\%
78
     Cutting planes:
79
      Gomory: 1
```

```
Cover: 77
 80
 81
     Implied bound: 1
     MIR: 7
 82
 83
      StrongCG: 4
      GUB cover: 26
 85
     RLT: 2
     Relax-and-lift: 24
 86
 87
     BQP: 1
 88
 89 Explored 1 nodes (25603 simplex iterations) in 26.80 seconds (46.24 work units)
 90 Thread count was 8 (of 8 available processors)
    Solution count 4: 803 1003 2123 3583
 93
 94 Optimal solution found (tolerance 1.00e-10)
    Best objective 8.030000000000e+02, best bound 8.03000000000e+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 2481701 rows, 1955335 columns and 17236208 nonzeros
102
103 Model fingerprint: 0x1e50b9ec
104 Variable types: 963295 continuous, 992040 integer (985965 binary)
105 Coefficient statistics:
106 Matrix range [1e-01, 1e+10]
107
     Objective range [6e-05, 5e+01]
108
     Bounds range [1e+00, 8e+01]
109
                   [8e-01, 1e+10]
     RHS range
110 Warning: Model contains large matrix coefficients
111 Warning: Model contains large rhs
112
          Consider reformulating model or setting NumericFocus parameter
          to avoid numerical issues.
113
114 Presolve removed 2479011 rows and 1954367 columns (presolve time = 5s) ...
115 Presolve removed 2479389 rows and 1954500 columns
116 Presolve time: 5.98s
117 Presolved: 2312 rows, 835 columns, 6149 nonzeros
118 Variable types: 5 continuous, 830 integer (502 binary)
119 Found heuristic solution: objective 3536.0500186
120
121 Root simplex log...
122
123 Iteration Objective
                           Primal Inf. Dual Inf.
                                                   Time
        0 5.9982796e+03 2.982021e+03 0.000000e+00
124
       699 4.3290500e+03 0.000000e+00 0.000000e+00
125
126
127 Root relaxation: objective 4.329050e+03, 699 iterations, 0.01 seconds (0.01 work units)
128
       Nodes | Current Node | Objective Bounds
129

↓ Work

130 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
131
                         4329.0500186 8215.74099 89.8% - 7s
132 H 0 0
                  - 0 4329.05002 4329.05002 0.00% - 7s
133
       0 0
134
135 Explored 1 nodes (979 simplex iterations) in 7.75 seconds (7.88 work units)
136 Thread count was 8 (of 8 available processors)
137
138 Solution count 2: 4329.05 3536.05
139
140 Optimal solution found (tolerance 1.00e-08)
141 Best objective 4.329050018628e+03, best bound 4.329050018628e+03, gap 0.0000%
142 SP is solved
143 SP's optimal solution is' □ 4329
144
145
     Itr = 0
146 Collect LB = [803.0]
147 Collect_UB = [9461.100037255623]
148 Collect_Hua = [0.0]
149 Collect_SPObjVal = [4329.050018627811]
150 Collect_MPObjValNHua = [803.0]
151
152
153 Set parameter TimeLimit to value 12000
154 Set parameter MIPGap to value 0.0005
155 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
156
157 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
158 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
159
160 Optimize a model with 563248 rows, 283978 columns and 1563500 nonzeros
161 Model fingerprint: 0x52047408
162 Variable types: 1 continuous, 283977 integer (283941 binary)
163 Coefficient statistics:
```

```
Matrix range [1e+00, 1e+10]
164
165
      Objective range [1e+00, 2e+01]
      Bounds range [1e+00, 1e+00]
166
167
     RHS range
                   [1e+00, 2e+10]
    Warning: Model contains large matrix coefficients
    Warning: Model contains large rhs
169
170
          Consider reformulating model or setting NumericFocus parameter
171
         to avoid numerical issues.
    Presolve removed 404286 rows and 266303 columns (presolve time = 5s) ...
172
    Presolve removed 537987 rows and 276495 columns
173
174
    Presolve time: 8.39s
175
    Presolved: 25261 rows, 7483 columns, 100784 nonzeros
176
    Variable types: 0 continuous, 7483 integer (7461 binary)
177
178 Root simplex log...
179
180 Iteration Objective
                          Primal Inf. Dual Inf.
                                                 Time
        0 5.1320500e+03 8.890000e+02 0.000000e+00
181
182
       4703 5.1320500e+03 0.000000e+00 0.000000e+00
183
184 Root relaxation: objective 5.132050e+03, 4703 iterations, 0.17 seconds (0.23 work units)
185
       Nodes | Current Node | Objective Bounds | Work
186
187
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
188
189
           0.5132.05002 \quad 0 \quad 36
                                    - 5132.05002
190
           0 5132.05002 0 134
                                    - 5132.05002
191
                                    - 5132.05002
       0
           0.5132.05002 0.132
                                                      - 10s
192
       0
           0 5132.05002
                         0 448
                                    - 5132.05002
                                                       - 11s
193
           0 5132.05002
                         0 418
                                    - 5132.05002
194
       0
           0 5132.05002 0 454
                                    - 5132.05002
                                                       - 11s
195
           0.5132.05002 0.156
                                    - 5132.05002
                                                      - 14s
       0
196
       0
           0.5132.05002 \quad 0.565
                                    - 5132.05002
                                                       - 15s
197
       0
           0 5132.05002
                         0 507
                                    - 5132.05002
                                                      - 19s
198
       0
           0 5132.05002
                         0 303
                                    - 5132.05002
                                    - 5132.05002
199
           0.5132.05002
                         0 297
                                                       - 19s
       0
200
       0
           0 5132.05002
                         0 514
                                    - 5132.05002
                                                         21s
201
       0
           0 5132.05002 0 340
                                    - 5132.05002
                        7652.0500186 5132.05002 32.9% - 28s
202 H 0
           0
203
           0.5132.05002 \quad 0.303.7652.05002.5132.05002.32.9\%
204 H 0
                        7052.0500186 5132.05002 27.2% - 30s
205 H
            0
                        6972.0500186 5132.05002 26.4%
                                                         - 30s
        0
                        6572.0500186 5132.05002 21.9%
206 H 0
           0
                                                         - 30s
207
           2 5132.05002 0 303 6572.05002 5132.05002 21.9%
           8 5132.05002 2 493 6572.05002 5132.05002 21.9% 7035 35s
208
           20 5134.13314  4 1219 6572.05002 5132.05002 21.9% 5430  42s
209
       15
           29 5132.05002 5 704 6572.05002 5132.05002 21.9% 4692 45s
210
       23
211
       57
           43 infeasible 9
                            6572.05002 5132.05002 21.9% 2834 52s
           72 5142.74236 12 1073 6572.05002 5132.05002 21.9% 2650 56s
212
       84
      185 196 5492.05002 24 366 6572.05002 5132.05002 21.9% 1533 60s
213
214 H 225 234
                          5932.0500186 5132.05002 13.5% 1272 60s
215 H 391 264
                          5852.0500186 5132.05002 12.3% 758 62s
      528 392 5150.86988 8 1944 5852.05002 5132.05002 12.3% 613 65s
216
217 H 592 228
                         5412.0500186 5132.05002 5.17% 584 67s
218
      599 240 5141.30069 12 753 5412.05002 5132.05002 5.17% 609
                                                                     70s
      763 215 5152.05002 44 610 5412.05002 5132.05002 5.17% 563
219
                          5332.0500186 5132.05002 3.75% 591 77s
220 H 807 229
      821 \ \ 238\ 5152.05002 \ \ 52\ \ 608\ 5332.05002\ \ 5132.05002\ \ 3.75\% \ \ 609
221
222
           154 5152.05002 55 303 5332.05002 5132.05002 3.75% 624
                                                                     91s
223
      894 158 5302.05002 5 646 5332.05002 5175.18834 2.94% 620 95s
      901 163 5272.05002 7 557 5332.05002 5192.05002 2.63% 615 100s
224
225 H 905 156
                          5232.0500186 5192.05002 0.76% 612 104s
226
227 Cutting planes:
228
     Learned: 1
229
      Gomory: 27
230
      Cover: 426
      Implied bound: 40
231
232
      Projected implied bound: 43
233
      Clique: 68
234
     MIR: 98
235
      StrongCG: 34
236
      Flow cover: 231
237
      GUB cover: 53
238
      Zero half: 92
239
      RLT: 13
      Relax-and-lift: 115
240
241
      BQP: 2
242
243 Explored 906 nodes (712058 simplex iterations) in 104.99 seconds (234.58 work units)
244
    Thread count was 8 (of 8 available processors)
245
246 Solution count 9: 5232.05 5332.05 5412.05 ... 7652.05
247
```

```
248 Optimal solution found (tolerance 5.00e-04)
249 Best objective 5.232050018628e+03, best bound 5.232050018628e+03, gap 0.0000%
250 Set parameter MIPGap to value 1e-08
251 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
252
253 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
254 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
255
256 Optimize a model with 2481701 rows, 1955335 columns and 17236208 nonzeros
257 Model fingerprint: 0x9ac0419f
258 Variable types: 963295 continuous, 992040 integer (985965 binary)
259 Coefficient statistics:
260 Matrix range [1e-01, 1e+10]
     Objective range [6e-05, 5e+01]
261
262
     Bounds range [1e+00, 8e+01]
                    [8e-01, 1e+10]
263 RHS range
264 Warning: Model contains large matrix coefficients
265 Warning: Model contains large rhs
266
          Consider reformulating model or setting NumericFocus parameter
267
          to avoid numerical issues.
268 Presolve removed 2476584 rows and 1953678 columns (presolve time = 5s) ...
269 Presolve removed 2476913 rows and 1953807 columns
270 Presolve time: 5.16s
271 Presolved: 4788 rows, 1528 columns, 12871 nonzeros
272 Variable types: 8 continuous, 1520 integer (882 binary)
273 Found heuristic solution: objective 3697.0500186
275 Root simplex log...
276
277 Iteration Objective
                           Primal Inf. Dual Inf.
278
        0 9.3735808e+03 3.644842e+03 0.000000e+00
279
       1353 5.2855807e+03 0.000000e+00 0.000000e+00
280
281 Root relaxation: objective 5.285581e+03, 1353 iterations, 0.03 seconds (0.02 work units)
282
283
       Nodes | Current Node | Objective Bounds

↓ Work

284
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
285
                         5285.5807430 13966.7410 164% - 6s
286 H 0 0
287
        0 0
                  - 0
                         5285.58074 5285.58074 0.00% - 6s
288
289 Explored 1 nodes (2074 simplex iterations) in 6.83 seconds (7.05 work units)
290 Thread count was 8 (of 8 available processors)
291
292 Solution count 2: 5285.58 3697.05
293
294 Optimal solution found (tolerance 1.00e-08)
295 Best objective 5.285580742960e+03, best bound 5.285580742960e+03, gap 0.0000%
296 SP is solved
297 SP's optimal solution is' ☐ 5285
298
299 Itr = 1
300 Collect LB = [803.0, 5232.050018627811]
301 Collect_UB = [9461.100037255623, 6188.580742959544]
302 Collect_Hua = [0.0, 4329.050018627811]
303 Collect SPObjVal = [4329.050018627811, 5285.580742959544]
304 Collect MPObjValNHua = [803.0, 903.0]
305
306
307 Set parameter TimeLimit to value 12000
308 Set parameter MIPGap to value 0.0005
309 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
310
311 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
312 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
313
314 Optimize a model with 563249 rows, 283978 columns and 1563519 nonzeros
315 Model fingerprint: 0x11d1c01e
316 Variable types: 1 continuous, 283977 integer (283941 binary)
317 Coefficient statistics:
318 Matrix range [1e+00, 1e+10]
     Objective range [1e+00, 2e+01]
319
     Bounds range [1e+00, 1e+00]
RHS range [1e+00, 2e+10]
320
321
     Warning: Model contains large matrix coefficients
322
     Warning: Model contains large rhs
323
324
          Consider reformulating model or setting NumericFocus parameter
325
          to avoid numerical issues.
326 Presolve removed 413430 rows and 267080 columns (presolve time = 5s) ...
327 Presolve removed 539041 rows and 276661 columns
328 Presolve time: 7.76s
329 Presolved: 24208 rows, 7317 columns, 96550 nonzeros
330 Variable types: 0 continuous, 7317 integer (7295 binary)
331
```

```
332 Root simplex log...
333
334 Iteration Objective
                          Primal Inf. Dual Inf.
                                                 Time
335
        0 6.1071522e+03 8.840000e+02 0.000000e+00
336
       3521 6.1071522e+03 0.000000e+00 0.000000e+00
337
338 Root relaxation: objective 6.107152e+03, 3521 iterations, 0.08 seconds (0.10 work units)
339
340
       Nodes | Current Node | Objective Bounds
                                                        Work
341
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
342
343
           0 6107.15217 0 34
                                    - 6107.15217
344
           0 6107.15217 0 136
                                    - 6107.15217
                                    - 6107.15217
                                                         9s
345
       0
           0 6107.15217
                         0 147
346
       0
           0 6107.15217
                         0 127
                                    - 6107.15217
                                                         9s
           0 6107.15217
                                    - 6107.15217
347
                         0 264
348
       0
           0 6107.15217 0 258
                                    - 6107.15217
           0 6107.15217
349
                                    - 6107.15217
                                                      - 10s
       0
                         0 226
350
           0 6107.15217 0 224
                                    - 6107.15217
351
       0
           0 6107.15217
                         0 427
                                    - 6107.15217
                                                      - 11s
352
           0.6107.15217 0.458
                                    -6107.15217
                                                      - 11s
       0
353
       0
           0 6107.15217 0 198
                                    - 6107.15217
                                                      - 14s
354
       0
           0 6107.15217 0 244
                                    - 6107.15217
355
       0
           0 6107.15217 0 220
                                    - 6107.15217
                                                      - 15s
356
           0 6107.15217 0 284
                                    - 6107.15217
       0
                                                      - 15s
357
       0
           0.6107.15217 \quad 0.264
                                    - 6107.15217
                                                      - 15s
358
       0
           0 6107.15217 0 113
                                    - 6107.15217
                                                   - - 17s
359 H 0 0
                        8827.1521715 6107.15217 30.8% - 17s
       0 0 6107.15217 0 67 8827.15217 6107.15217 30.8%
360
                        7087.1521715 6107.15217 13.8% - 18s
361 H 0 0
362 H 0
           0
                        6707.1521715 6107.15217 8.95%
                                                           19s
           2 6107.15217 0 67 6707.15217 6107.15217 8.95% -
363
       0
364
          10 6107.15217 3 149 6707.15217 6107.15217 8.95% 1245 20s
           47 6107.15217 11 205 6707.15217 6107.15217 8.95% 1304 25s
365
       50
366 H 69 65
                         6567.1521715 6107.15217 7.00% 1251 26s
                          6367.1521715 6107.15217 4.08% 930 28s
367 H 117 100
368
      174 121 6107.15217 31 249 6367.15217 6107.15217 4.08% 794
                    6307.1521715 6107.15217 3.17% 523 33s
369 H 368 214
                          6267.1521715 6107.15217 2.55% 439 34s
370 H 529 255
371
      552 264 6107.15217 61 311 6267.15217 6107.15217 2.55% 422
                                                                    35s
372 H 557 264
                          6247.1521715 6107.15217 2.24% 420 35s
373 H 562 264
                          6207.1521715 6107.15217 1.61% 417
                                                               358
                          6167.1521715 6107.15217 0.97% 372 35s
374 H 642 275
375
     1003 75 6107.15217 18 565 6167.15217 6107.15217 0.97% 288
                          6127.1521715 6107.15217 0.33% 285 40s
376 H 1016 75
377
378 Explored 1120 nodes (365288 simplex iterations) in 41.75 seconds (85.45 work units)
379
    Thread count was 8 (of 8 available processors)
380
381 Solution count 10: 6127.15 6167.15 6207.15 ... 7087.15
382
383 Optimal solution found (tolerance 5.00e-04)
384 Best objective 6.127152171531e+03, best bound 6.127152171531e+03, gap 0.0000%
385 Set parameter MIPGap to value 1e-08
386 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
387
388 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
389 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
390
391 Optimize a model with 2481701 rows, 1955335 columns and 17236208 nonzeros
392 Model fingerprint: 0x23d88fe7
393 Variable types: 963295 continuous, 992040 integer (985965 binary)
394 Coefficient statistics:
395
     Matrix range [1e-01, 1e+10]
396
     Objective range [6e-05, 5e+01]
397
     Bounds range [1e+00, 8e+01]
398
     RHS range
                   [8e-01, 1e+10]
    Warning: Model contains large matrix coefficients
399
400 Warning: Model contains large rhs
401
         Consider reformulating model or setting NumericFocus parameter
402
         to avoid numerical issues.
403 Presolve removed 2476869 rows and 1953786 columns (presolve time = 5s) ...
404 Presolve removed 2476901 rows and 1953806 columns
405 Presolve time: 5.17s
406 Presolved: 4800 rows, 1529 columns, 12833 nonzeros
407
    Variable types: 8 continuous, 1521 integer (884 binary)
408 Found heuristic solution: objective 3487.2950287
409
410 Root simplex log...
411
412 Iteration Objective
                          Primal Inf. Dual Inf.
                                                 Time
        0 9.0775808e+03 3.707917e+03 0.000000e+00
413
       1505 \quad 5.0582241e + 03 \quad 0.000000e + 00 \quad 0.000000e + 00
414
415
```

```
416 Root relaxation: objective 5.058224e+03, 1505 iterations, 0.01 seconds (0.02 work units)
417
418
       Nodes | Current Node | Objective Bounds
                                                            Work
419
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
420
421
        0 0 5058.22411 0 22 3487.29503 5058.22411 45.0% - 6s
                         5057.8528892 5058.22411 0.01% - 6s
422 H 0 0
423
424 Cutting planes:
425
      Gomory: 1
426
      Clique: 2
427
      MIR: 3
428
      Flow cover: 1
429
      Zero half: 1
430
431 Explored 1 nodes (2015 simplex iterations) in 6.85 seconds (7.46 work units)
    Thread count was 8 (of 8 available processors)
432
433
434 Solution count 2: 5057.85 3487.3
435
436 Optimal solution found (tolerance 1.00e-08)
437 Best objective 5.057852889165e+03, best bound 5.057852889165e+03, gap 0.0000%
438
     SP is solved
439 SP's optimal solution is' □ 5057
440
441 \quad Itr = 2
442 Collect LB = [803.0, 5232.050018627811, 6127.152171530973]
443 Collect_UB = [9461.100037255623, 6188.580742959544, 5899.424317736787]
444 Collect_Hua = [0.0, 4329.050018627811, 5285.580742959544]
445 Collect_SPObjVal = [4329.050018627811, 5285.580742959544, 5057.852889165359]
446 Collect MPObjValNHua = [803.0, 903.0, 841.5714285714284]
447
448
449
     Ops, stop iteration
450
     Values adopted from the Itr-1' th iteration, and Itr = \{2\}, judgeCount = \{1\}
451
452
               ~~judgeCount = 1, SPObj_SPF = 5285.580742959544
453 Vessel i: 0:
                  pi: 0-6, ai-di: 70-81,
                                          gi SP-gpi SP: 0.000000-0.000000,
                                                                                ai SP-di: 70-81,
                                                                                                   taoi-deltai: 70-81,
                                                                                                                       taoPi SP-deltaPi SP: 70-81,
                                                                                                                                                     betaNi:
          bi: 11
     11.
454
    Vessel i: 1:
                  pi: 0-6,
                             ai-di: 13-31,
                                            gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                ai_SP-di: 13-31,
                                                                                                   taoi-deltai: 13-31,
                                                                                                                       taoPi_SP-deltaPi_SP: 13-31,
                                                                                                                                                      betaNi:
     18, bi: 18
     Vessel i: 2:
                  pi: 6-13,
                              ai-di: 27-50,
                                             gi SP-gpi SP: 0.000000-0.000000,
                                                                                                                        taoPi SP-deltaPi SP: 27-50,
                                                                                  ai SP-di: 27-50,
                                                                                                    taoi-deltai: 27-50.
                                                                                                                                                       betaNi
           bi: 23
     : 23,
     Vessel i: 3:
                  pi: 13-20,
                               ai-di: 25-49,
                                              gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                   ai SP-di: 25-49,
                                                                                                     taoi-deltai: 25-49,
                                                                                                                          taoPi SP-deltaPi SP: 25-49,
     betaNi: 24,
                  bi: 24
     Vessel i: 4:
                  pi: 20-26,
                               ai-di: 31-37,
                                              gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                   ai_SP-di: 31-37,
                                                                                                     taoi-deltai: 31-37,
                                                                                                                          taoPi_SP-deltaPi_SP: 31-37,
     betaNi: 6,
                 bi: 6
     Vessel i: 5:
                  pi: 28-34,
                               ai-di: 16-38,
                                              gi_SP-gpi_SP: 0.214286-0.700000,
                                                                                   ai_SP-di: 17-38,
                                                                                                     taoi-deltai: 21-32,
                                                                                                                          taoPi_SP-deltaPi_SP: 21-32,
     betaNi: 11,
                  bi: 11
                   pi: 14-19,
     Vessel i: 6:
                               ai-di: 6-24,
                                             gi_SP-gpi_SP: 1.000000-0.000000,
                                                                                  ai_SP-di: 14-24,
                                                                                                    taoi-deltai: 10-16,
                                                                                                                        taoPi SP-deltaPi SP: 14-16,
                                                                                                                                                      betaNi
          bi: 6
     : 6,
     Vessel i: 7:
                                                                                                                          taoPi_SP-deltaPi_SP: 39-41,
                  pi: 27-34,
                               ai-di: 30-49,
                                              gi_SP-gpi_SP: 0.900000-0.700000,
                                                                                   ai_SP-di: 39-49,
                                                                                                     taoi-deltai: 36-41,
     betaNi: 5.
                 bi: 5
                  pi: 27-34,
                                              gi_SP-gpi_SP: 0.285714-1.000000,
                                                                                                                          taoPi_SP-deltaPi_SP: 42-61,
     Vessel i: 8:
                               ai-di: 40-73,
                                                                                   ai_SP-di: 42-73,
                                                                                                     taoi-deltai: 42-61,
     betaNi: 19,
                  bi: 19
462
463 round LB = [803, 5232, 6127]
464 round UB = [9461, 6189, 5899]
465
    round Hua = [0, 4329, 5286]
466 round SPObjVal = [4329, 5286, 5058]
467 round MPObjValNHua = [803, 903, 842]
468
469 OptimalObj = 6127.152171530973
470 Time: 636.000000
471
472
473
474
```