```
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=33758
     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 481534 rows, 46641 columns and 1344872 nonzeros
19
     Model fingerprint: 0x3e7421da
     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
     Warning: Model contains large rhs
27
28
             Consider reformulating model or setting NumericFocus parameter
29
            to avoid numerical issues.
     Presolve removed 262377 rows and 19927 columns (presolve time = 5s) ...
30
31
     Presolve removed 424133 rows and 30617 columns
     Presolve time: 8.40s
     Presolved: 57401 rows, 16024 columns, 231304 nonzeros
34
     Variable types: 0 continuous, 16024 integer (16000 binary)
35
     Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
     Showing first log only...
37
38
39
     Root relaxation presolved: 57396 rows, 16029 columns, 231289 nonzeros
40
41
42
     Root simplex log...
43
44
     Iteration Objective
                                    Primal Inf. Dual Inf.
           0 8.4300000e+02 7.187500e+01 1.524365e+08
45
46
     Concurrent spin time: 0.02s
48
     Solved with dual simplex (primal model)
49
50
     Root relaxation: objective 8.430000e+02, 2419 iterations, 0.32 seconds (0.31 work units)
51
        Nodes | Current Node | Objective Bounds
52
                                                                               Work
53
      Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
54
         0 \quad \  \  0 \ \ 843.00000 \quad \  \  0 \ \ \ 22
55
                                                 - 843.00000
                                 3883.0000000 843.00000 78.3% -
56
    H = 0 = 0
57
     Η
         0
                0
                                 2023.0000000 843.00000 58.3%
             0 843.00000 0 148 2023.00000 843.00000 58.3% -
59 H 0 0
                                 1963.0000000 843.00000 57.1% - 10s
60
              0 843.00000 0 148 1963.00000 843.00000 57.1%
              0 843.00000 0 86 1963.00000 843.00000 57.1% - 12s
62
              0 843.00000 0 80 1963.00000 843.00000 57.1%
                                 1323.0000000 843.00000 36.3% - 12s
63 H 0 0
              0 843.00000 0 14 1323.00000 843.00000 36.3% - 14s
64
         0
              0\ 843.00000\ 0\ 19\ 1323.00000\ 843.00000\ 36.3\%
65
66 H 0 0
                                  883.0000000 843.00000 4.53% - 14s
              0\ 843.00000\ 0\ 87\ 883.00000\ 843.00000\ 4.53\%\ -\ 15s
67
68
               0 843.00000
                                 0 99 883.00000 843.00000 4.53%
69
              0 843.00000 0 25 883.00000 843.00000 4.53%
70
              0 843 00000 0 211 883 00000 843 00000 4 53%
         0
                                                                                     - 20s
71
         0
              0 843.00000 0 279 883.00000 843.00000 4.53%
                                                                                         20s
    H 0
                                  843.0000000 843.00000 0.00% - 20s
73
74
     Cutting planes:
       Gomory: 9
76
       Lift-and-project: 2
       Cover: 46
77
78
       Implied bound: 3
79
       Clique: 21
```

```
MIR: 28
 80
 81
      StrongCG: 18
      GUB cover: 10
 82
 83
      Zero half: 2
      RLT: 17
 85
      Relax-and-lift: 54
 86
      BOP: 3
 87
 88 Explored 1 nodes (30905 simplex iterations) in 21.37 seconds (36.73 work units)
 89 Thread count was 8 (of 8 available processors)
 90
 91 Solution count 6: 843 883 1323 ... 3883
 92
 93 Optimal solution found (tolerance 1.00e-10)
 94 Best objective 8.430000000000e+02, best bound 8.43000000000e+02, gap 0.0000%
    Set parameter MIPGap to value 1e-08
 96 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
 98 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
100
101 Optimize a model with 1983204 rows, 1559473 columns and 13693357 nonzeros
102 Model fingerprint: 0xd0c8d0c8
103 Variable types: 766961 continuous, 792512 integer (787112 binary)
104 Coefficient statistics:
105 Matrix range [1e-01, 1e+10]
106 Objective range [6e-05, 5e+01]
      Bounds range [1e+00, 8e+01]
107
                    [8e-01, 1e+10]
108
      RHS range
109 Warning: Model contains large matrix coefficients
110 Warning: Model contains large rhs
          Consider reformulating model or setting NumericFocus parameter
111
112
          to avoid numerical issues.
113 Presolve removed 1978251 rows and 1557811 columns
114 Presolve time: 4.13s
115 Presolved: 4953 rows, 1662 columns, 13084 nonzeros
116 Variable types: 6 continuous, 1656 integer (953 binary)
117 Found heuristic solution: objective 3879.1111111
118 Found heuristic solution: objective 3899.1111111
119
120 Root simplex log...
121
                          Primal Inf. Dual Inf.
122 Iteration Objective
123
         0 1.1382000e+04 5.068677e+03 0.000000e+00
       1590 5.6051111e+03 0.000000e+00 0.000000e+00
124
125
126 Root relaxation: objective 5.605111e+03, 1590 iterations, 0.02 seconds (0.02 work units)
127
128
       Nodes | Current Node | Objective Bounds
129 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
130
                         5605.1111111 15291.7778 173% - 5s
131 H 0 0
       0 0
                  - 0
                         5605.11111 5605.11111 0.00% - 5s
132
133
134 Explored 1 nodes (2002 simplex iterations) in 5.43 seconds (5.92 work units)
135 Thread count was 8 (of 8 available processors)
136
137 Solution count 3: 5605.11 3899.11 3879.11
138
139 Optimal solution found (tolerance 1.00e-08)
140 Best objective 5.6051111111111e+03, best bound 5.605111111111e+03, gap 0.0000%
141 SP is solved
142 SP's optimal solution is' ☐ 5605
143
144 	ext{ Itr} = 0
145 Collect_LB = [843.0]
146 Collect_UB = [12053.222222222222]
147 Collect_Hua = [0.0]
148 Collect SPObjVal = [5605.111111111113]
149 Collect_MPObjValNHua = [843.0]
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 918834 rows, 246921 columns and 2721754 nonzeros
159 Model fingerprint: 0x49ec2d1c
160 Variable types: 1 continuous, 246920 integer (236784 binary)
161 Coefficient statistics:
162
      Matrix range [1e-01, 1e+10]
      Objective range [1e+00, 2e+01]
163
```

```
Bounds range
                     [1e+00, 1e+00]
164
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 718229 rows and 223947 columns (presolve time = 5s) ...
171 Presolve removed 726369 rows and 224600 columns (presolve time = 10s) ...
    Presolve removed 852160 rows and 234271 columns
173 Presolve time: 13.24s
174 Presolved: 66674 rows, 12650 columns, 250807 nonzeros
175
    Variable types: 1 continuous, 12649 integer (10481 binary)
176
177
    Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
178
    Showing first log only...
180 Root relaxation presolved: 12650 rows, 79324 columns, 263457 nonzeros
181
182
183 Root simplex log...
184
185 Iteration Objective
                           Primal Inf. Dual Inf.
                                                  Time
        0 \quad 6.4481111e{+03} \quad 0.000000e{+00} \quad 3.761177e{+04} \\
186
187
    Concurrent spin time: 0.17s
188
189
    Solved with dual simplex (primal model)
190
191
    Root relaxation: objective 6.448111e+03, 6967 iterations, 1.15 seconds (1.44 work units)
192
    Total elapsed time = 15.80s
193
194
                                  Objective Bounds
                                                         Work
       Nodes | Current Node |
195
     Expl\ Unexpl\mid\ Obj\ \ Depth\ IntInf\mid\ Incumbent \quad BestBd\quad Gap\mid\ It/Node\ Time
196
197
           0 6448.11111 0 276
                                     - 6448.11111
198
           0.6448.11111
                         0 707
                                     - 6448.11111
                                                       - 22s
       0
199
           0.6448.11111
                         0 690
                                     - 6448.11111
                                                       - 22s
200
       0
           0 6448.11111
                         0 620
                                     - 6448.11111
                                                       - 23s
201
           0 6448.11111
                         0 295
                                     - 6448.11111
202
           0.6448.11111
                         0 289
                                     - 6448.11111
                                                       - 40s
       0
203
       0
           0 6448.11111
                         0 255
                                     - 6448.11111
                                                       - 43s
204
           0 6448.11111
                         0 257
                                     - 6448.11111
                                                       - 50s
205
           0 6448.11111
                         0 321
                                     - 6448.11111
                                                       - 51s
       0
                                                       - 61s
206
                         0.330
       0
           0.6448 11111
                                     - 6448.11111
207
           0 6448.11111
                         0 310
                                     - 6448.11111
                                                    - - 63s
208
           2 6448.11111
                         0 310
                                     - 6448.11111
                                                       - 68s
                                                    - 11599 70s
209
           4 6448.11111 1 402
                                     - 6448.11111
       1
210
       7
           12 6448.11111 3 873
                                     - 6448.11111
                                                     - 5074 75s
211
           20 6448.11111 4 1283
                                       - 6448.11111
                                                     - 6630 85s
212
       19
           24 6448.11111 4 597
                                      - 6448.11111
                                                     - 6687 90s
213
       32
           37 6448.11111 6 560
                                      - 6448.11111
                                                     - 5545 97s
214
       36
           58 6448.11111
                           7 544
                                      - 6448.11111
                                                     - 5442 104s
           93 6448.11111 11 773
215
                                       - 6448.11111
                                                     - 4650 113s
                                                      - 3842 125s
216
      103
           138 6468.56851 18 2017
                                        - 6448.11111
217
      198
           184 6448.11111
                            5 1439
                                       - 6448.11111
                                                       - 2733 132s
218
      295 265 6448.11111 11 700
                                       - 6448.11111
                                                       - 2134 139s
219
      401
           387 6448.11111 16 900
                                        - 6448.11111
                                                       - 1700 144s
                                                       - 1266 150s
220
      561 556 6448.11111 26 620
                                        - 6448.11111
221
      789 793 6448.11111 36 621
                                        - 6448.11111
                                                       - 922 155s
222
      1086 1032 6448.11111 51 461
                                         - 6448.11111
                                                       - 699 161s
223
      1377 1132 6448.11111 61 489
                                                        - 577 166s
                                         - 6448.11111
                                         - 6448.11111
224
      1543 1158 6468.11111 70 1201
                                                        - 549 172s
225
      1602 1159 6688.11111 29 310
                                         - 6448.11111
                                                        - 560 198s
226
      1604 1160 7588.11111 187 515
                                         - 6448.11111
                                                        - 559 208s
227
      1605 1161 6448.11111 150 659
                                         - 6448.11111
                                                        - 559 223s
228
      1606 1162 7468.11111 358 713
                                         - 6448.11111
                                                           558 229s
229
      1607 1162 7528.11111 599 551
                                          - 6448.11111
                                                           558 243s
230
      1608 1163 7548.11111 410 758
                                          - 6448.11111
                                                           557 249s
                                                        - 557 267s
231
      1609 1164 7668 11111 215 907
                                         - 6448.11111
232
      1610 1164 6448.11111 51 1076
                                         - 6448.11111
                                                         - 557 289s
233
      1611 1165 7508.11111 293 1044
                                          - 6448.11111
                                                           556 323s
234
      1612 1166 7548.11111 123 990
                                                         - 556 329s
                                          - 6448.11111
      1613 1166 7548.11111 204 961
235
                                         - 6448.11111
                                                         - 556 361s
236
      1614 1167 7468.11111 601 1353
                                          - 6448.11111
                                                        - 555 374s
      1615 1168 7328.11111 33 674
237
                                         - 6448.11111
                                                        - 555 407s
238
     1616 1168 7428.11111 571 538
                                                        - 555 411s
                                         - 6448 11111
239 H 1616 1109
                            6448.1111111 6448.11111 0.00% 555 426s
240
241
    Cutting planes:
242
     Learned: 2
243
     Gomory: 1
244
      Cover: 471
     Implied bound: 820
245
246
     Projected implied bound: 49
247
      Clique: 785
```

```
248
      MIR: 114
249
      StrongCG: 80
      Flow cover: 392
250
251
      GUB cover: 51
252
      Zero half: 20
253
      RLT: 52
254
      Relax-and-lift: 121
255
      BQP: 15
256
257 Explored 1616 nodes (1293220 simplex iterations) in 426.55 seconds (991.43 work units)
258 Thread count was 8 (of 8 available processors)
259
260 Solution count 1: 6448.11
261
262 Optimal solution found (tolerance 5.00e-02)
263 Best objective 6.448111111111e+03, best bound 6.448111111111e+03, gap 0.0000%
    Set parameter MIPGap to value 1e-08
264
265 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
266
267 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
268 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
269
270 Optimize a model with 1983204 rows, 1559473 columns and 13693357 nonzeros
271 Model fingerprint: 0x628abfbb
272 Variable types: 766961 continuous, 792512 integer (787112 binary)
273 Coefficient statistics:
274 Matrix range [1e-01, 1e+10]
      Objective range [6e-05, 5e+01]
275
276
      Bounds range [1e+00, 8e+01]
277
                    [8e-01, 1e+10]
      RHS range
278 Warning: Model contains large matrix coefficients
279 Warning: Model contains large rhs
280
          Consider reformulating model or setting NumericFocus parameter
          to avoid numerical issues.
281
282 Presolve removed 1977412 rows and 1557598 columns
283 Presolve time: 4.00s
284 Presolved: 5792 rows, 1875 columns, 15428 nonzeros
285 Variable types: 6 continuous, 1869 integer (1078 binary)
286 Found heuristic solution: objective 4013.1111111
287
288 Root simplex log...
289
290 Iteration Objective
                          Primal Inf. Dual Inf.
291
         0 1.1588000e+04 7.539023e+03 0.000000e+00
292
       1710 5.7831111e+03 0.000000e+00 0.000000e+00
293
294 Root relaxation: objective 5.783111e+03, 1710 iterations, 0.02 seconds (0.02 work units)
295
296
       Nodes | Current Node | Objective Bounds
297
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
298
299 *
                      0 5783.1111111 5783.11111 0.00% - 5s
300
301 Explored 1 nodes (2218 simplex iterations) in 5.33 seconds (5.70 work units)
302 Thread count was 8 (of 8 available processors)
303
304 Solution count 2: 5783.11 4013.11
305
306 Optimal solution found (tolerance 1.00e-08)
307 Best objective 5.783111111111e+03, best bound 5.783111111111e+03, gap 0.0000%
308 SP is solved
309 SP's optimal solution is' ☐ 5783
310
311
     Itr = 1
312 Collect_LB = [843.0, 6448.111111111111]
313 Collect_UB = [12053.2222222226, 6626.111111111113]
314 Collect_Hua = [0.0, 5605.111111111113]
315 Collect_SPObjVal = [5605.111111111113, 5783.11111111113]
316 Collect MPObjValNHua = [843.0, 843.0]
317
318
319 Set parameter MIPGap to value 0.05
320 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
321
322 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
323 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
324
325 Optimize a model with 1348788 rows, 264417 columns and 4091262 nonzeros
326 Model fingerprint: 0xc30003d2
327 Variable types: 1 continuous, 264416 integer (244176 binary)
328 Coefficient statistics:
      Matrix range [1e-01, 1e+10]
329
330
      Objective range [1e+00, 2e+01]
      Bounds range [1e+00, 1e+00]
331
```

```
[1e+00, 2e+10]
332
      RHS range
333
    Warning: Model contains large matrix coefficients
    Warning: Model contains large rhs
334
335
          Consider reformulating model or setting NumericFocus parameter
336
         to avoid numerical issues.
337 Presolve removed 1099815 rows and 236086 columns (presolve time = 5s) ...
338 Presolve removed 1123080 rows and 237835 columns (presolve time = 10s) ...
339 Presolve removed 1123080 rows and 237835 columns (presolve time = 15s) ...
340 Presolve removed 1238220 rows and 246750 columns
341 Presolve time: 19.43s
342 Presolved: 110568 rows, 17667 columns, 406401 nonzeros
343
    Variable types: 1 continuous, 17666 integer (13354 binary)
344
345 Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
346
    Showing first log only...
347
348 Root relaxation presolved: 17667 rows, 128235 columns, 424068 nonzeros
349
350
351 Root simplex log...
352
353 Iteration Objective
                           Primal Inf. Dual Inf.
                                                  Time
354
        0 6.6261111e+03 0.000000e+00 7.289923e+04
355
       19633 6.6261111e+03 0.000000e+00 0.000000e+00 23s
356
      19633 6.6261111e+03 0.000000e+00 0.000000e+00
357
    Concurrent spin time: 0.35s
358
359
    Solved with primal simplex
360
    Root relaxation: objective 6.626111e+03, 19633 iterations, 3.18 seconds (4.37 work units)
361
362
    Total elapsed time = 26.05s
363
364
       Nodes | Current Node |
                                  Objective Bounds
                                                     | Work
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
365
366
367
           0.6626.11111
                         0.751
                                     - 6626.11111
                                                         299
368
       0
           0 6626.11111
                         0.988
                                     - 6626.11111
369
       0
           0 6626.11111
                         0 994
                                     - 6626.11111
                                                       - 37s
370
                         0 955
                                     - 6626.11111
                                                       - 37s
       0
           0.6626.11111
371
       0
           0 6626.11111
                         0.900
                                     - 6626.11111
                                                         39s
           0 6626.11111
                         0 897
                                     - 6626.11111
372
                                                         39s
373
           0 6626.11111
                         0 512
                                     - 6626.11111
                                                         49s
       0
                                                       - 51s
374
                         0.517
                                     - 6626.11111
       0
           0.6626.11111
375
       0
           0 6626.11111
                         0 497
                                     - 6626.11111
                                                       - 60s
376
       0
           0 6626.11111
                         0 600
                                     - 6626.11111
                                                         62s
                                                       - 72s
377
       0
           0 6626.11111
                         0 720
                                     - 6626.11111
378
       0
           0 6626.11111
                         0 718
                                     - 6626.11111
                                                       - 72s
379
       0
           0 6626.11111
                         0 677
                                     - 6626.11111
                                                         75s
380
           0 6626.11111
                         0 680
                                     - 6626.11111
                                                       - 75s
       0
381
       0
           0.6626.11111
                         0 555
                                     - 6626.11111
                                                       - 82s
382
       0
           0 6626.11111
                         0 555
                                     - 6626.11111
                                                       - 86s
383
           2 6626.11111
                         0 555
                                     - 6626.11111
                                                      - 101s
384
           8 6626.11111 2 978
                                                    - 9383 109s
       3
                                     - 6626.11111
385
       7
           12 6626.11111 3 1059
                                      - 6626.11111
                                                    - 7745 113s
386
       11
           16 6626.11111 4 1105
                                      - 6626.11111
                                                     - 7385 118s
387
       15
           20 6626.11111 4 1531
                                      - 6626.11111
                                                     - 7568 125s
                                                     - 6464 133s
388
       19
           24 6626.11111
                          5 1169
                                      - 6626.11111
389
       23
           29 6626.11111
                           5 1394
                                      - 6626.11111
                                                     - 6065 136s
390
       32
           48 6626.11111
                           7 1340
                                      - 6626.11111
                                                      - 5331 145s
391
       49
           78 6626.11111 8 1322
                                                     - 4285 162s
                                      - 6626.11111
392
       92 139 6626.11111 11 582
                                       - 6626,11111
                                                      - 3784 180s
393
      196
           182 6626.11111
                            7 1254
                                       - 6626.11111
                                                      - 2627 193s
      294 227 6626.11111 9 1193
394
                                       - 6626.11111
                                                       - 2000 205s
395
      418 270 6626.11111 17 507
                                                      - 1562 215s
                                       - 6626.11111
      509\ \ 307\ 6626.111111\ \ 36\ \ 977
                                                      - 1382 226s
396
                                       - 6626.11111
397
      548 354 6626.11111 46 946
                                       - 6626.11111
                                                      - 1454 239s
                                                      - 1442 257s
398
      608 443 6626.11111 63 952
                                       - 6626.11111
399
      723 686 6626.11111 104 781
                                                      - 1340 284s
                                        - 6626.11111
400
      1012 1428 6626.11111 181 783
                                         - 6626.11111
                                                       - 1044 324s
      1256 1428 7026.11111 184 1492
401
                                          - 6626.11111
                                                        - 860 325s
402
      1824 1981 6646.11111 423 679
                                                        - 625 348s
                                         - 6626.11111
403
      2477 2434 infeasible 624
                                      - 6626.11111
                                                    - 504 368s
404
      3085 3287 7246.11111 427 732
                                         - 6626.11111
                                                        - 443 383s
405
      4024 3288 6766.11111 420 555
                                         - 6626.11111
                                                          358 439s
406
      4026 3289 6906.11111 708 770
                                         - 6626 11111
                                                          358 475s
407
      4027 3290 7246.11111 401 888
                                         - 6626.11111
                                                          358 514s
408
      4028 3291 6846.11111 31 1293
                                          - 6626.11111
                                                        - 358 538s
409
      4029 3291 7326.11111 134 733
                                         - 6626.11111
                                                        - 358 563s
410
      4030 3292 7086.11111 489 1049
                                                        - 358 587s
                                          - 6626.11111
411
      4031 3293 7146.11111 392 1565
                                          - 6626.11111
                                                           358 634s
412
      4032
           3293 7126.11111 535 1486
                                          - 6626.11111
                                                           358 646s
                                                        - 357 695s
413
      4033 3294 6846.11111 676 1254
                                          - 6626.11111
                                                        - 357 754s
414
      4034 3295 7246.11111 398 1564
                                          - 6626.11111
      4035 3295 6626.11111 19 1403
                                         - 6626.11111
                                                        -
                                                          357 838s
415
```

```
416 H 4035 3130
                             6926.1111111 6626.11111 4.33% 357 860s
417
418 Cutting planes:
419
     Learned: 3
420 Gomory: 7
421
     Lift-and-project: 2
      Cover: 555
422
423
     Implied bound: 648
      Projected implied bound: 43
424
      Clique: 1294
425
426
      MIR: 161
427
      StrongCG: 62
428
      Flow cover: 723
429
      GUB cover: 460
430
      Zero half: 36
431
      RLT: 62
432
      Relax-and-lift: 328
      BOP: 19
433
434
      PSD: 3
435
436 Explored 4035 nodes (1958117 simplex iterations) in 861.03 seconds (2094.78 work units)
437 Thread count was 8 (of 8 available processors)
438
439 Solution count 1: 6926.11
440
441 Optimal solution found (tolerance 5.00e-02)
442 Best objective 6.9261111111111e+03, best bound 6.626111111111e+03, gap 4.3314%
443 Warning: linear constraint 488881 and linear constraint 918835 have the same name "ConSP25_1[0,0]"
444 Set parameter MIPGap to value 1e-08
445 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
446
447 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
448 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
449
450 Optimize a model with 1983204 rows, 1559473 columns and 13693357 nonzeros
451 Model fingerprint: 0x6e000478
452 Variable types: 766961 continuous, 792512 integer (787112 binary)
453 Coefficient statistics:
     Matrix range [1e-01, 1e+10]
454
455
     Objective range [6e-05, 5e+01]
     Bounds range [1e+00, 8e+01]
456
457
     RHS range
                    [8e-01, 1e+10]
458 Warning: Model contains large matrix coefficients
459 Warning: Model contains large rhs
          Consider reformulating model or setting NumericFocus parameter
460
          to avoid numerical issues.
461
462 Presolve removed 1977003 rows and 1557513 columns
463 Presolve time: 3.81s
464 Presolved: 6201 rows, 1960 columns, 16532 nonzeros
465 Variable types: 6 continuous, 1954 integer (1122 binary)
466 Found heuristic solution: objective 3988.1111111
467
468 Root relaxation: objective 5.783111e+03, 1966 iterations, 0.03 seconds (0.02 work units)
469
470
       Nodes | Current Node | Objective Bounds

↓ Work

471 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
472
                         5783.1111111 17677.7778 206% - 4s
473 H 0 0
474
           0
                  - 0
                         5783.11111 5783.11111 0.00% - 4s
475
476 Explored 1 nodes (2788 simplex iterations) in 5.09 seconds (5.56 work units)
477
    Thread count was 8 (of 8 available processors)
478
479 Solution count 2: 5783.11 3988.11
480
481 Optimal solution found (tolerance 1.00e-08)
482 Best objective 5.783111111111e+03, best bound 5.783111111111e+03, gap 0.0000%
483 SP is solved
484 SP's optimal solution is' ☐ 5783
485
486
     Itr = 2
487 Collect LB = [843.0, 6448.111111111113, 6926.111111111113]
488 Collect_UB = [12053.22222222226, 6626.1111111111113, 6626.111111111113]
489 Collect Hua = [0.0, 5605.111111111113, 5783.111111111113]
490 Collect_SPObjVal = [5605.1111111111113, 5783.111111111113, 5783.111111111113]
491 Collect MPObjValNHua = [843.0, 843.0, 1143.0]
492
493
494
     Reach the termination conditions, stop iteration
495
     Values adopted from the judgeCount's th iteration, and Itr = \{2\}, judgeCount = \{1\}
496
                ~judgeCount = 1, SPObj SPF = 5783.111111111111
497
                  pi: 0-7, ai-di: 3-34, gi_SP-gpi_SP: 0.000000-0.000000, ai_SP-di: 3-34, taoi-deltai: 3-32, taoPi_SP-deltaPi_SP: 3-32,
498 Vessel i: 0:
                                                                                                                                             betaNi: 29
        bi: 29
```

unknown						
499 Vessel i: 1: pi: 13	3-18, ai-di: 12-22,	gi_SP-gpi_SP: 0.000000-0.000000,	ai_SP-di: 12-22,	taoi-deltai: 12-20,	taoPi_SP-deltaPi_SP: 12-20,	
betaNi: 8, bi: 8 500 Vessel i: 2: pi: 14	I-19, ai-di: 27-35,	gi_SP-gpi_SP: 0.000000-0.000000,	ai_SP-di: 27-35,	taoi-deltai: 27-33,	taoPi_SP-deltaPi_SP: 27-33,	
betaNi: 6, bi: 6 501 Vessel i: 3: pi: 7- : 34, bi: 34	14, ai-di: 24-60,	gi_SP-gpi_SP: 0.000000-0.000000,	ai_SP-di: 24-60,	taoi-deltai: 24-58,	taoPi_SP-deltaPi_SP: 24-58,	betaNi
502 Vessel i: 4: pi: 14 betaNi: 4, bi: 4	I-19, ai-di: 35-41,	gi_SP-gpi_SP: 0.000000-0.000000,	ai_SP-di: 35-41,	taoi-deltai: 35-39,	taoPi_SP-deltaPi_SP: 35-39,	
503 Vessel i: 5: pi: 20 betaNi: 15, bi: 15		gi_SP-gpi_SP: 0.000000-1.000000,	ai_SP-di: 31-60,	taoi-deltai: 31-46,	taoPi_SP-deltaPi_SP: 31-46,	
504 Vessel i: 6: pi: 13 betaNi: 24, bi: 24	5-21, ai-di: 40-80,	gi_SP-gpi_SP: 1.000000-0.600000,	ai_SP-di: 48-80,	taoi-deltai: 48-72,	taoPi_SP-deltaPi_SP: 48-72,	
505 Vessel i: 7: pi: 28 betaNi: 13, bi: 13	3-34, ai-di: 43-72,	gi_SP-gpi_SP: 0.800000-0.200000,	ai_SP-di: 51-72,	taoi-deltai: 51-64,	taoPi_SP-deltaPi_SP: 51-64,	
506 507 round LB = [843, 6 508 round UB = [1205, 5 509 round Hua = [0, 56 510 round SPObjVal = 511 round MPObjValNI 512 513 Time: 1696.000000 514 515 516 517	3, 6626, 6626] 05, 5783]	13]				