```
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=46401
     import sys; print('Python %s on %s' % (sys.version, sys.platform))
     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
    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 648826 rows, 58701 columns and 1805708 nonzeros
    Model fingerprint: 0x71546b27
     Variable types: 1 continuous, 58700 integer (58660 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 292891 rows and 15988 columns (presolve time = 5s) ...
     Presolve removed 292891 rows and 15988 columns (presolve time = 10s) ...
31
     Presolve removed 292891 rows and 15988 columns (presolve time = 15s) ...
    Presolve removed 539391 rows and 36153 columns
34
     Presolve time: 17.57s
35
     Presolved: 109435 rows, 22548 columns, 339203 nonzeros
     Variable types: 0 continuous, 22548 integer (22518 binary)
37
     Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
38
39
     Showing first log only...
40
41
     Root relaxation presolved: 22548 rows, 131983 columns, 361751 nonzeros
42
43
44
    Root simplex log...
45
46
    Iteration Objective
                                    Primal Inf. Dual Inf.
          0 6.8400000e+02 0.000000e+00 1.054000e+03
48
     Concurrent spin time: 0.00s
49
50
     Solved with dual simplex (primal model)
52
     Root relaxation: objective 6.840000e+02, 4274 iterations, 0.88 seconds (1.23 work units)
53
     Total elapsed time = 20.60s
54
55
                                              Objective Bounds
        Nodes | Current Node |
56
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
57
58
             0 684.00000 0 38
                                                - 684.00000
59 H 0 0
                                5844.0000000 684.00000 88.3% - 21s
        0 \quad 0 \quad 684.00000 \quad 0 \quad 104 \quad 5844.00000 \quad 684.00000 \quad 88.3\%
60
              0\ 684.00000\ 0\ 79\ 5844.00000\ 684.00000\ 88.3\%
    H \quad 0 \quad 0
                                 4204.0000000 684.00000 83.7% - 22s
62
63
              0 684.00000 0 77 4204.00000 684.00000 83.7% - 22s
64
              0 684.00000 0 18 4204.00000 684.00000 83.7%
                                 1544.0000000 684.00000 55.7%
65
    Η
         0
              0 684.00000 0 27 1544.00000 684.00000 55.7% - 25s
         0
66
67
         0
              0 684.00000 0 60 1544.00000 684.00000 55.7%
                                                                                    - 26s
68
         0
              0 684.00000 0 112 1544.00000 684.00000 55.7%
69
              0 684.00000 0 36 1544.00000 684.00000 55.7%
70 H 0
                                 1124 0000000 684 00000 39 1%
              0
         0
              0 684.00000 0 75 1124.00000 684.00000 39.1%
              0\ 684.00000\ 0\ 175\ 1124.00000\ 684.00000\ 39.1\%
73
         0
              0 684.00000 0 37 1124.00000 684.00000 39.1%
74
              0 684.00000 0 237 1124.00000 684.00000 39.1%
                                                                                     - 35s
         0
75
              0 684.00000 0 197 1124.00000 684.00000 39.1%
                                                                                         35s
76
              0 684.00000
                                 0 149 1124.00000 684.00000 39.1%
                                                                                         35s
              0 684,00000 0 59 1124,00000 684,00000 39.1%
77
         0
                                                                                    - 39s
              0\ 684.00000\ 0\ 58\ 1124.00000\ 684.00000\ 39.1\%
78
         0
                                                                                    - 39s
         0
                                 1084.0000000 684.00000 36.9%
79
    Η
```

```
80
          0 684.00000 0 150 1084.00000 684.00000 36.9%
       0
 81 H 0 0
                         924.0000000 684.00000 26.0% - 39s
       0 0 684.00000 0 206 924.00000 684.00000 26.0%
 82
                                                             - 41s
 83
       0
           0 684.00000 0 43 924.00000 684.00000 26.0%
                                                               42s
           0 684.00000 0 43 924.00000 684.00000 26.0%
 85
       0
           0 684.00000 0 229 924.00000 684.00000 26.0%
                                                             - 46s
           0 684.00000 0 226 924.00000 684.00000 26.0%
                                                             - 46s
 86
       0
                                                             - 47s
 87
       0 0 684.00000 0 347 924.00000 684.00000 26.0%
                         684.0000000 684.00000 0.00% - 48s
 88 H 0 0
          0 684.00000 0 25 684.00000 684.00000 0.00%
 89
       0
 90
 91
    Cutting planes:
 92
     Gomory: 2
 93
     Cover: 103
 94
     Implied bound: 977
 95
      Clique: 56
 96
     MIR: 25
      StrongCG: 17
 97
 98
     GUB cover: 21
 99
     RLT: 6
100
     Relax-and-lift: 10
101
     PSD: 2
102
103 Explored 1 nodes (69720 simplex iterations) in 48.81 seconds (80.64 work units)
104 Thread count was 8 (of 8 available processors)
105
106 Solution count 7: 684 924 1084 ... 5844
107
108 Optimal solution found (tolerance 1.00e-10)
109 Best objective 6.840000000000e+02, best bound 6.84000000000e+02, gap 0.0000%
110 Set parameter MIPGap to value 1e-08
111 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
112
113 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
114 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
115
116 Optimize a model with 3035833 rows, 2395885 columns and 21185866 nonzeros
117 Model fingerprint: 0x4fb8607a
118 Variable types: 1181973 continuous, 1213912 integer (1207162 binary)
119 Coefficient statistics:
120 Matrix range [1e-01, 1e+10]
121
     Objective range [6e-05, 5e+01]
     Bounds range [1e+00, 8e+01]
122
123
     RHS range
                   [8e-01, 1e+10]
124 Warning: Model contains large matrix coefficients
125 Warning: Model contains large rhs
126
          Consider reformulating model or setting NumericFocus parameter
127
         to avoid numerical issues.
128 Presolve removed 3033045 rows and 2394852 columns (presolve time = 5s) ...
129 Presolve removed 3033329 rows and 2394938 columns
130 Presolve time: 6.36s
131 Presolved: 2504 rows, 947 columns, 6695 nonzeros
    Variable types: 10 continuous, 937 integer (563 binary)
132
133 Found heuristic solution: objective 3279.6104410
134 Found heuristic solution: objective 3440.6104410
135
136 Root simplex log...
137
138 Iteration Objective
                           Primal Inf. Dual Inf.
        0 8.2792222e+03 2.755776e+03 0.000000e+00
139
       783 4.8948590e+03 0.000000e+00 0.000000e+00
140
141
Root relaxation: objective 4.894859e+03, 783 iterations, 0.02 seconds (0.01 work units)
143
144
       Nodes | Current Node | Objective Bounds
                                                     Work
145
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
146
       0 \quad 0 \; 4894.85898 \quad 0 \; \; 54\; 3440.61044\; 4894.85898 \; \; 42.3\%
147
148 H 0 0
                        4891.7251799 4894.85898 0.06% - 8s
       0 0 4893.27025 0 23 4891.72518 4893.27025 0.03%
149
                                                                 8s
       0 0 4893.27025 0 12 4891.72518 4893.27025 0.03% -
150
                                                                 8s
       0 \quad 0 \; 4893.27025 \quad 0 \quad 9 \; 4891.72518 \; 4893.27025 \; \; 0.03\% \quad -
151
152 H 0 0
                       4892.3829521 4893.27025 0.02% - 8s
       0 0 cutoff 0 4892.38295 4892.38295 0.00% - 8s
153
154
155 Cutting planes:
156
     Gomory: 1
157
     MIR: 1
158
     RLT: 1
159
     Relax-and-lift: 1
160
161 Explored 1 nodes (1478 simplex iterations) in 8.43 seconds (9.28 work units)
162 Thread count was 8 (of 8 available processors)
163
```

```
164 Solution count 4: 4892.38 4891.73 3440.61 3279.61
165
166 Optimal solution found (tolerance 1.00e-08)
167
    Best objective 4.892382952071e+03, best bound 4.892382952071e+03, gap 0.0000%
169 SP's optimal solution is'□4892
170
171
     Itr = 0
172 Collect LB = [684.0]
173 Collect_UB = [10468.7659041425]
174 Collect_Hua = [0.0]
175 Collect_SPObjVal = [4892.38295207125]
176 Collect MPObjValNHua = [684.0]
177
178
179
    Set parameter TimeLimit to value 12000
180
    Set parameter MIPGap to value 0.0005
     Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
181
182
183 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
184 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
185
     Optimize a model with 654152 rows, 344301 columns and 1811099 nonzeros
186
187 Model fingerprint: 0x0f17104a
188 Variable types: 1 continuous, 344300 integer (344260 binary)
189 Coefficient statistics:
190 Matrix range [1e+00, 1e+10]
      Objective range [1e+00, 2e+01]
191
192
      Bounds range [1e+00, 1e+00]
193
                   [1e+00, 2e+10]
     RHS range
194
     Warning: Model contains large matrix coefficients
195
    Warning: Model contains large rhs
196
          Consider reformulating model or setting NumericFocus parameter
197
          to avoid numerical issues.
198 Presolve removed 342656 rows and 308396 columns (presolve time = 5s) ...
199 Presolve removed 342656 rows and 308396 columns (presolve time = 10s) ...
200 Presolve removed 342656 rows and 308396 columns (presolve time = 15s) ...
201 Presolve removed 342656 rows and 308396 columns (presolve time = 20s) ...
202 Presolve removed 577229 rows and 327628 columns
203 Presolve time: 24.14s
204 Presolved: 76923 rows, 16673 columns, 242083 nonzeros
205 Variable types: 0 continuous, 16673 integer (16643 binary)
206
207 Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
208 Showing first log only...
209
210 Root relaxation presolved: 16673 rows, 93596 columns, 258756 nonzeros
211
212
213 Root simplex log...
214
215 Iteration Objective
                           Primal Inf. Dual Inf.
        0 5.5810258e+03 0.000000e+00 5.837000e+03
216
217 Concurrent spin time: 0.00s
218
219 Solved with dual simplex (primal model)
220
221 Root relaxation: objective 5.581026e+03, 7662 iterations, 0.94 seconds (1.76 work units)
222
223
       Nodes | Current Node | Objective Bounds
                                                          Work
224
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
225
226
           0 5581.02581 0 29
                                     - 5581.02581
227
       0
           0 5581.02581 0 99
                                     - 5581.02581
                                                       - 28s
228
       0
           0 5581.02581 0 211
                                     - 5581.02581
                                                    - - 28s
229
           0.5581.02581 \quad 0.103
                                     - 5581.02581
230 H 0 0
                        8281.0258092 5581.02581 32.6%
231
           0.5581.02581 0.128.8281.02581.5581.02581.32.6%
232
        0
           0 5581.02581 0 107 8281.02581 5581.02581 32.6%
233 H 0
                         8201.0258092 5581.02581 31.9% - 33s
234 H 0
                         7561.0258092 5581.02581 26.2%
            0
235
           0 5581.02581 0 241 7561.02581 5581.02581 26.2%
                                                                  34s
236
           0 5581.02581
                          0 165 7561.02581 5581.02581 26.2%
237
                          0 207 7561.02581 5581.02581 26.2%
           0 5581.02581
238
           0 5581.02581 0 371 7561.02581 5581.02581 26.2%
        0
                                                                - 38s
239
       0
           0 5581.02581
                          0 221 7561.02581 5581.02581 26.2%
                                                                - 41s
240
           0.5581.02581 \quad 0.170.7561.02581.5581.02581.26.2\%
                                                                - 41s
                        7181.0258092 5581.02581 22.3% - 43s
5581 0258092 5581.02581 0.00% - 46s
241 H 0 0
242 H 0 0
243
          0 5581.02581 0 170 5581.02581 5581.02581 0.00%
244
245 Cutting planes:
246
     Learned: 1
247
      Gomory: 1
```

```
unknown
248
      Cover: 49
249
      Implied bound: 32
      Clique: 446
250
251
      MIR: 81
252
      StrongCG: 54
253
      GUB cover: 7
254
      Zero half: 3
255
     RLT: 9
256
      Relax-and-lift: 17
257
      BOP: 79
258
      PSD: 1
259
260 Explored 1 nodes (100005 simplex iterations) in 46.08 seconds (79.33 work units)
261 Thread count was 8 (of 8 available processors)
262
263 Solution count 5: 5581.03 7181.03 7561.03 ... 8281.03
264
265 Optimal solution found (tolerance 5.00e-04)
266 Best objective 5.581025809214e+03, best bound 5.581025809214e+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 3035833 rows, 2395885 columns and 21185866 nonzeros
274 Model fingerprint: 0x144eec69
275 Variable types: 1181973 continuous, 1213912 integer (1207162 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]
281 Warning: Model contains large matrix coefficients
282 Warning: Model contains large rhs
283
          Consider reformulating model or setting NumericFocus parameter
284
          to avoid numerical issues.
285 Presolve removed 3031118 rows and 2394350 columns (presolve time = 5s) ...
286 Presolve removed 3031170 rows and 2394365 columns
287 Presolve time: 5.99s
288 Presolved: 4663 rows, 1520 columns, 12447 nonzeros
289 Variable types: 10 continuous, 1510 integer (884 binary)
290 Found heuristic solution: objective 3772,3644878
291 Found heuristic solution: objective 3801.2533767
292
293 Root simplex log...
294
295 Iteration Objective
                          Primal Inf. Dual Inf.
         0 8.8640000e+03 4.513912e+03 0.000000e+00
296
297
       1893 5.4099444e+03 0.000000e+00 0.000000e+00
298
299 Root relaxation: objective 5.409944e+03, 1893 iterations, 0.03 seconds (0.04 work units)
300
       Nodes | Current Node | Objective Bounds
301
                                                         Work
302
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
303
        0 0 5409.94444 0 4 3801.25338 5409.94444 42.3% - 7s
304
                         5407.9005126 5409.94444 0.04% - 7s
305 H 0 0
306
       0
           0
                      0 5409.9444444 5409.94444 0.00%
307
308 Cutting planes:
309
      Gomory: 1
310 GUB cover: 1
311
      RLT: 1
312
313 Explored 1 nodes (2544 simplex iterations) in 8.06 seconds (8.63 work units)
314 Thread count was 8 (of 8 available processors)
315
316 Solution count 4: 5409.94 5407.9 3801.25 3772.36
317
318 Optimal solution found (tolerance 1.00e-08)
319 Best objective 5.40994444444e+03, best bound 5.40994444444e+03, gap 0.0000%
320 SP is solved
321 SP's optimal solution is' ☐ 5409
322
323 Itr = 1
324 Collect_LB = [684.0, 5581.025809214107]
325 Collect_UB = [10468.7659041425, 6098.587301587302]
326 Collect Hua = [0.0, 4892.38295207125]
327 Collect SPObjVal = [4892.38295207125, 5409.944444444445]
328 Collect MPObjValNHua = [684.0, 688.6428571428569]
329
330
331 Set parameter TimeLimit to value 12000
```

```
332
    Set parameter MIPGap to value 0.0005
333 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
334
335 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
336 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
337
338 Optimize a model with 654153 rows, 344301 columns and 1811120 nonzeros
339 Model fingerprint: 0x91b3b71d
340 Variable types: 1 continuous, 344300 integer (344260 binary)
341 Coefficient statistics:
     Matrix range [1e+00, 1e+10]
342
343
      Objective range [1e+00, 2e+01]
344
      Bounds range [1e+00, 1e+00]
     RHS range
                   [1e+00, 2e+10]
345
346
     Warning: Model contains large matrix coefficients
347 Warning: Model contains large rhs
348
          Consider reformulating model or setting NumericFocus parameter
349
          to avoid numerical issues.
350 Presolve removed 343650 rows and 308501 columns (presolve time = 5s) ...
351 Presolve removed 343650 rows and 308501 columns (presolve time = 10s) ...
352 Presolve removed 343650 rows and 308501 columns (presolve time = 15s) ...
353 Presolve removed 343650 rows and 308501 columns (presolve time = 20s) ...
354 Presolve removed 583691 rows and 327685 columns
355 Presolve time: 23.90s
356 Presolved: 70462 rows, 16616 columns, 235024 nonzeros
357
    Variable types: 0 continuous, 16616 integer (16586 binary)
358
359 Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
360 Showing first log only...
361
362 Root relaxation presolved: 16616 rows, 87078 columns, 251640 nonzeros
363
364
365 Root simplex log...
366
367 Iteration Objective
                           Primal Inf. Dual Inf.
                                                  Time
368
         0 6.1084444e+03 0.000000e+00 5.838000e+03
369
    Concurrent spin time: 0.20s
370
371
     Solved with dual simplex (primal model)
372
373 Root relaxation: objective 6.108444e+03, 7058 iterations, 1.16 seconds (1.98 work units)
374
375
       Nodes | Current Node |
                                  Objective Bounds
                                                         Work
376
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
377
           0.6108.44444 0 44
378
                                    - 6108.44444
                                                       - 26s
379
           0 6108.44444 0 47
                                    - 6108.44444
380
           0 6108.44444 0 114
                                     - 6108.44444
381
           0 6108.44444 0 112
                                     - 6108.44444
       0
                                                        - 28s
382
       0
           0 6108.44444 0 142
                                     - 6108.44444
                                                       - 29s
           0 6108.44444 0 200
383
                                     - 6108.44444
384
           0 6108.44444 0 249
                                     - 6108.44444
       0
                                                        - 33s
                                                       - 36s
385
           0.6108.44444 0.166
       0
                                     - 6108.44444
386
       0
           0 6108.44444 0 333
                                     - 6108.44444
                                                   - - 38s
387
       0
           0 6108.44444 0 178
                                     - 6108.44444
                                                        - 40s
                       12528.444444 6108.44444 51.2% - 41s
388 H 0 0
       0 0 6108.44444 0 178 12528.4444 6108.44444 51.2%
389
390 H 0 0
                        8408.4444444 6108.44444 27.4% - 42s
                                                          - 45s
391 H 0 0
                        6108.4444444 6108.44444 0.00%
392
       0 0 6108.44444 0 178 6108.44444 6108.44444 0.00%
393
394 Cutting planes:
395
     Gomory: 2
396
      Cover: 72
397
      Implied bound: 24
398
      Clique: 1837
399
      MIR: 109
400
      StrongCG: 67
      GUB cover: 32
401
402
      Zero half: 3
403
      RLT: 8
404
      Relax-and-lift: 13
      BQP: 71
405
406
      PSD: 1
407
408 Explored 1 nodes (73307 simplex iterations) in 45.41 seconds (64.68 work units)
409 Thread count was 8 (of 8 available processors)
410
411 Solution count 3: 6108.44 8408.44 12528.4
412
413 Optimal solution found (tolerance 5.00e-04)
414 Best objective 6.10844444444e+03, best bound 6.1084444444e+03, gap 0.0000%
415 Set parameter MIPGap to value 1e-08
```

```
416 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
417
418 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
419
    Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
420
421
     Optimize a model with 3035833 rows, 2395885 columns and 21185866 nonzeros
422 Model fingerprint: 0x1582cf2e
423 Variable types: 1181973 continuous, 1213912 integer (1207162 binary)
424 Coefficient statistics:
      Matrix range [1e-01, 1e+10]
425
426
      Objective range [6e-05, 5e+01]
427
      Bounds range [1e+00, 8e+01]
428
      RHS range
                     [8e-01, 1e+10]
429 Warning: Model contains large matrix coefficients
430 Warning: Model contains large rhs
431
          Consider reformulating model or setting NumericFocus parameter
432
          to avoid numerical issues.
433 Presolve removed 3031525 rows and 2394433 columns (presolve time = 5s) ...
434 Presolve removed 3031569 rows and 2394448 columns
435 Presolve time: 5.81s
436 Presolved: 4264 rows, 1437 columns, 11446 nonzeros
437
     Variable types: 10 continuous, 1427 integer (841 binary)
     Found heuristic solution: objective 3740.9042488
438
439 Found heuristic solution: objective 3780.9042488
440
441 Root simplex log...
442
443 Iteration Objective
                            Primal Inf. Dual Inf.
                                                    Time
         0 8.8770000e+03 3.924648e+03 0.000000e+00
444
445
       1595 5.4249444e+03 0.000000e+00 0.000000e+00
446
447 Root relaxation: objective 5.424944e+03, 1595 iterations, 0.03 seconds (0.03 work units)
448
449
       Nodes | Current Node | Objective Bounds
450
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
451
452 *
                      0 5424.9444444 5424.94444 0.00% - 7s
453
454 Explored 1 nodes (2055 simplex iterations) in 7.82 seconds (8.12 work units)
455
    Thread count was 8 (of 8 available processors)
456
457
     Solution count 3: 5424.94 3780.9 3740.9
458
459 Optimal solution found (tolerance 1.00e-08)
460 Best objective 5.42494444444e+03, best bound 5.4249444444e+03, gap 0.0000%
461 SP is solved
462 SP's optimal solution is' ☐ 5424
463
464 	ext{ Itr} = 2
465 Collect LB = [684.0, 5581.025809214107, 6108.44444444445]
466 Collect UB = [10468.7659041425, 6098.587301587302, 6098.587301587302]
467 Collect_Hua = [0.0, 4892.38295207125, 5409.944444444445]
468 Collect SPObjVal = [4892.38295207125, 5409.94444444445, 5424.94444444445]
469 Collect_MPObjValNHua = [684.0, 688.6428571428569, 698.5]
470
471
472
     Ops, stop iteration
473
     Values adopted from the Itr-1' th iteration, and Itr = \{2\}, judgeCount = \{1\}
474
475
                 ~judgeCount = 1, SPObj SPF = 5409.944444444445
                                           gi_SP-gpi_SP: 0.000000-0.000000,
476
    Vessel i: 0:
                   pi: 0-5,
                            ai-di: 28-81,
                                                                                 ai SP-di: 28-81,
                                                                                                   taoi-deltai: 28-35,
                                                                                                                       taoPi SP-deltaPi SP: 28-35,
                                                                                                                                                      betaNi:
          bi: 7
     Vessel i: 1:
                   pi: 0-5,
                            ai-di: 15-45,
                                            gi SP-gpi SP: 0.000000-0.000000,
                                                                                 ai SP-di: 15-45,
                                                                                                   taoi-deltai: 15-21,
                                                                                                                       taoPi SP-deltaPi SP: 15-21,
                                                                                                                                                      betaNi:
         bi: 6
     Vessel i: 2:
                   pi: 5-10,
                              ai-di: 19-50,
                                             gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                  ai_SP-di: 19-50,
                                                                                                    taoi-deltai: 19-28,
                                                                                                                        taoPi_SP-deltaPi_SP: 19-28,
                                                                                                                                                       betaNi
          bi: 9
                   pi: 10-16,
     Vessel i: 3:
                               ai-di: 9-55,
                                             gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                  ai SP-di: 9-55,
                                                                                                   taoi-deltai: 9-35,
                                                                                                                      taoPi SP-deltaPi SP: 9-35,
                                                                                                                                                  betaNi: 26
         bi: 26
480
     Vessel i: 4:
                   pi: 22-27,
                               ai-di: 20-42,
                                              gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                   ai SP-di: 20-42,
                                                                                                     taoi-deltai: 20-25,
                                                                                                                         taoPi SP-deltaPi SP: 20-25,
     betaNi: 5,
                 bi: 5
                  pi: 17-22,
                                                                                                                      taoPi_SP-deltaPi_SP: 4-12, betaNi: 8
481
     Vessel i: 5:
                                             gi_SP-gpi_SP: 0.000000-1.000000,
                                                                                  ai_SP-di: 3-61,
                                                                                                   taoi-deltai: 4-12.
                               ai-di: 3-61.
         bi: 8
     Vessel i: 6:
                   pi: 16-22,
                               ai-di: 9-72,
                                             gi_SP-gpi_SP: 0.875000-0.200000,
                                                                                  ai_SP-di: 16-72,
                                                                                                    taoi-deltai: 16-33,
                                                                                                                         taoPi_SP-deltaPi_SP: 16-33,
                                                                                                                                                       betaNi
     : 17, bi: 17
483
                   pi: 24-29,
                                                                                                                       taoPi SP-deltaPi SP: 10-12, betaNi:
     Vessel i: 7:
                               ai-di: 2-77.
                                             gi_SP-gpi_SP: 0.800000-0.800000,
                                                                                  ai_SP-di: 10-77,
                                                                                                    taoi-deltai: 6-12.
         bi: 6
     Vessel i: 8:
                   pi: 28-34,
                               ai-di: 22-62,
                                              gi_SP-gpi_SP: 0.325000-1.000000,
                                                                                   ai_SP-di: 24-62,
                                                                                                      taoi-deltai: 26-36,
                                                                                                                          taoPi_SP-deltaPi_SP: 26-36,
     betaNi: 10.
                   bi: 10
485
                                              gi_SP-gpi_SP: 1.000000-0.000000,
                                                                                                                          taoPi SP-deltaPi SP: 35-58,
     Vessel i: 9:
                   pi: 17-24,
                               ai-di: 28-79,
                                                                                   ai SP-di: 35-79,
                                                                                                     taoi-deltai: 35-58,
     betaNi: 23,
                   bi: 23
486
487 round LB = [684, 5581, 6108]
488 round UB = [10469, 6099, 6099]
489 round Hua = [0, 4892, 5410]
```

unknown

490	round SPObiVal = [4892-5410-5425]
491	round MPObjValNHua = [684, 689, 698]
492	round SPObjVal = [4892, 5410, 5425] round MPObjValNHua = [684, 689, 698] OptimalObj = 6108.44444444445 Time: 679.000000
493	OptimalObj = 6108.44444444445
494	Time: 679.000000
495	
497	
496 497 498	
L	