```
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=55399
 3
   import sys; print('Python %s on %s' % (sys.version, sys.platform))
   sys.path.extend(|'E:\\1 000\\3 0000\\1 00000\\1 000000\\1 00000\\1 LW 0000\\4 0000\\3 python code\\9 Code for this
   6
   PyDev console: starting.
   Python 3.9.7 (tags/v3.9.7:1016ef3, Aug 30 2021, 20:19:38) [MSC v.1929 64 bit (AMD64)] on win32
 8
   >>> runfile('E:/1 000/3 0000/1 00000/1 000000/1 000000/1 000000/1 LW 000/3 python_code/9 Code for this paper/main_RO_TWS.py', wdir='E:/1 0000/3 0000/1 000000/1 000000/1 000000/1 000000/1 LW 000/3 python_code/9 Code for
   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 361160 rows, 34789 columns and 995570 nonzeros
19
   Model fingerprint: 0xd26ac180
   Variable types: 1 continuous, 34788 integer (34764 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 320138 rows and 23992 columns (presolve time = 5s) ...
   Presolve removed 320138 rows and 23992 columns
31
   Presolve time: 5.08s
   Presolved: 41022 rows, 10797 columns, 146176 nonzeros
    Variable types: 0 continuous, 10797 integer (10782 binary)
34
35
   Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
   Showing first log only...
37
38
39
   Root relaxation presolved: 41022 rows, 10797 columns, 146176 nonzeros
40
41
42
   Root simplex log...
43
44
   Iteration Objective
                         Primal Inf. Dual Inf.
       0 1.2020000e+03 5.150000e+01 8.888983e+07
45
46
   Concurrent spin time: 0.02s
48
   Solved with dual simplex (primal model)
49
50
   Root relaxation: objective 6.820000e+02, 1686 iterations, 0.22 seconds (0.15 work units)
51
52
      Nodes | Current Node | Objective Bounds
                                                      Work
53
    Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
54
      0 \quad \  \  0 \ \ 682.00000 \quad \  \  0 \quad \  \  8
55
                                 - 682.00000
                      1622.0000000 682.00000 58.0% - 6s
56
   H \quad 0 \quad 0
57
      0 0 682.00000 0 133 1622.00000 682.00000 58.0% -
        0 682.00000 0 132 1622.00000 682.00000 58.0% -
59 H 0 0
                       1202.0000000 682.00000 43.3% - 6s
60
   H = 0
          0
                       682.0000000 682.00000 0.00% -
62
   Cutting planes:
63
    Gomory: 1
64
    Cover: 23
65
    Implied bound: 474
    Clique: 1
66
67
    MIR: 7
68
    GUB cover: 4
69
    RLT: 1
70
    Relax-and-lift: 4
71
    BQP: 1
73
   Explored 1 nodes (4505 simplex iterations) in 7.50 seconds (11.33 work units)
74
   Thread count was 8 (of 8 available processors)
76
   Solution count 3: 682 1202 1622
78
   Optimal solution found (tolerance 1.00e-10)
   Best objective 6.820000000000e+02, best bound 6.82000000000e+02, gap 0.0000%
```

```
80 Set parameter MIPGap to value 1e-08
 81 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
 83 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
 84 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
 85
 86 Optimize a model with 252657 rows, 9618 columns and 522313 nonzeros
 87 Model fingerprint: 0xb9981503
    Variable types: 24 continuous, 9594 integer (5544 binary)
 89 Coefficient statistics:
     Matrix range [1e-01, 1e+10]
 90
 91
      Objective range [6e-05, 5e+01]
      Bounds range [1e+00, 1e+00]
                    [8e-01, 1e+10]
 93
     RHS range
 94
     Warning: Model contains large matrix coefficients
     Warning: Model contains large rhs
 96
          Consider reformulating model or setting NumericFocus parameter
 97
          to avoid numerical issues.
 98 Presolve removed 250208 rows and 8721 columns
    Presolve time: 0.23s
100 Presolved: 2449 rows, 897 columns, 6631 nonzeros
101 Variable types: 0 continuous, 897 integer (507 binary)
102 Found heuristic solution: objective 3134.6666667
103 Found heuristic solution: objective 3194.6666667
104
105 Root relaxation: objective 4.522667e+03, 799 iterations, 0.00 seconds (0.01 work units)
106
107
       Nodes | Current Node | Objective Bounds

↓ Work

108 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
109
110 H 0 0
                         4522.6666667 9482.66667 110% - 0s
                  - 0 4522.66667 4522.66667 0.00% - 0s
       0 0
111
112
113 Explored 1 nodes (1042 simplex iterations) in 0.31 seconds (0.44 work units)
114 Thread count was 8 (of 8 available processors)
115
116 Solution count 3: 4522.67 3194.67 3134.67
117
118 Optimal solution found (tolerance 1.00e-08)
119 Best objective 4.522666666667e+03, best bound 4.522666666667e+03, gap 0.0000%
120 SP is solved
121 SP's optimal solution is' □ 4522
122
123 Itr = 0
124 Collect_LB = [682.0]
125 Collect_UB = [9727.333333333333]
126 Collect_Hua = [0.0]
127 Collect_SPObjVal = [4522.66666666668]
128 Collect MPObjValNHua = [682.0]
129
130
131 Set parameter MIPGap to value 1e-10
132 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
133
134 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
135 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
136
137 Optimize a model with 365023 rows, 137605 columns and 999448 nonzeros
138 Model fingerprint: 0xabd410af
139 Variable types: 1 continuous, 137604 integer (137580 binary)
140 Coefficient statistics:
      Matrix range [1e+00, 1e+10]
141
142 Objective range [1e+00, 2e+01]
143
     Bounds range [1e+00, 1e+00]
                   [1e+00, 2e+10]
144
     RHS range
145 Warning: Model contains large matrix coefficients
146 Warning: Model contains large rhs
147
          Consider reformulating model or setting NumericFocus parameter
148
          to avoid numerical issues.
149 Presolve removed 252328 rows and 123356 columns (presolve time = 5s) ...
150 Presolve removed 346305 rows and 131205 columns
151 Presolve time: 5.53s
152
    Presolved: 18718 rows, 6400 columns, 77369 nonzeros
153 Variable types: 0 continuous, 6400 integer (6385 binary)
154
155 Root simplex log...
156
157 Iteration Objective
                           Primal Inf. Dual Inf.
                                                   Time
         0 5.3246667e+03 6.260000e+02 0.000000e+00
158
159
       2249 5.3246667e+03 0.000000e+00 0.000000e+00
160
Root relaxation: objective 5.324667e+03, 2249 iterations, 0.06 seconds (0.07 work units)
162
                  Current Node
                                   Objective Bounds
163
       Nodes
```

```
164
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
165
        0 0 5324.66667 0 7
                                    - 5324.66667
166
167 H 0 0
                        7024.6666667 5324.66667 24.2%
       0 0 5324.66667 0 19 7024.66667 5324.66667 24.2%
168
169
       0
           0 5324.66667 0 24 7024.66667 5324.66667 24.2%
                                                                    6s
           0 5324.66667 0 15 7024.66667 5324.66667 24.2%
170
       0
171
          0 5324.66667 0 179 7024.66667 5324.66667 24.2%
            0.5324.66667 \quad 0.150.7024.66667.5324.66667.24.2\%
172
                                                                    7s
       0 \quad 0 \ 5324.66667 \quad 0 \ 149 \ 7024.66667 \ 5324.66667 \ 24.2\%
173
                                                                    7s
                        5324.6666667 5324.66667 0.00% - 8s
174 H 0 0
175
       0 \quad 0 \; 5324.66667 \quad 0 \quad 2 \; 5324.66667 \; 5324.66667 \; 0.00\%
176
177 Cutting planes:
178
     Lift-and-project: 1
      Cover: 206
179
180
      Implied bound: 604
      Clique: 1090
181
182
      MIR: 120
183
      StrongCG: 73
      GUB cover: 16
184
185
      Zero half: 19
      RLT: 10
186
187
      Relax-and-lift: 24
188
      BOP: 5
189
190 Explored 1 nodes (11392 simplex iterations) in 8.13 seconds (11.27 work units)
191 Thread count was 8 (of 8 available processors)
192
193 Solution count 2: 5324.67 7024.67
194
195 Optimal solution found (tolerance 1.00e-10)
196 Best objective 5.32466666667e+03, best bound 5.32466666667e+03, gap 0.0000%
197
     Set parameter MIPGap to value 1e-08
198 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
199
200 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
201 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
202
203 Optimize a model with 252657 rows, 9618 columns and 522313 nonzeros
204 Model fingerprint: 0xeb036f9f
205 Variable types: 24 continuous, 9594 integer (5544 binary)
206 Coefficient statistics:
207
      Matrix range [1e-01, 1e+10]
      Objective range [6e-05, 5e+01]
208
      Bounds range [1e+00, 1e+00]
209
                    [8e-01, 1e+10]
210
     RHS range
211
     Warning: Model contains large matrix coefficients
212 Warning: Model contains large rhs
          Consider reformulating model or setting NumericFocus parameter
213
214
          to avoid numerical issues.
215 Presolve removed 249896 rows and 8676 columns
216 Presolve time: 0.23s
217 Presolved: 2761 rows, 942 columns, 7440 nonzeros
218 Variable types: 0 continuous, 942 integer (530 binary)
219
220 Root relaxation: objective 4.752667e+03, 1042 iterations, 0.02 seconds (0.01 work units)
221
222
       Nodes | Current Node | Objective Bounds
    Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
223
224
225 H 0 0
                         4752.6666667 9972.66667 110% - 0s
226
                  - 0 4752.66667 4752.66667 0.00% - 0s
227
228 Explored 1 nodes (1299 simplex iterations) in 0.33 seconds (0.45 work units)
229 Thread count was 8 (of 8 available processors)
230
231 Solution count 1: 4752.67
232
233 Optimal solution found (tolerance 1.00e-08)
234 Best objective 4.752666666667e+03, best bound 4.752666666667e+03, gap 0.0000%
235 SP is solved
236 SP's optimal solution is'□4752
237
238 Itr = 1
239 Collect LB = [682.0, 5324.66666666668]
240 Collect_UB = [9727.33333333336, 5554.666666666666]
241 Collect_Hua = [0.0, 4522.6666666668]
242 Collect_SPObjVal = [4522.6666666668, 4752.66666666666]
243 Collect MPObjValNHua = [682.0, 802.0]
244
245
246 Set parameter MIPGap to value 1e-10
247 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
```

```
248
249 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
250 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
251
252 Optimize a model with 365023 rows, 137605 columns and 999448 nonzeros
253 Model fingerprint: 0x87c31eee
254 Variable types: 1 continuous, 137604 integer (137580 binary)
255 Coefficient statistics:
     Matrix range [1e+00, 1e+10]
256
257
     Objective range [1e+00, 2e+01]
258
     Bounds range [1e+00, 1e+00]
259
      RHS range
                    [1e+00, 2e+10]
260 Warning: Model contains large matrix coefficients
261 Warning: Model contains large rhs
262
          Consider reformulating model or setting NumericFocus parameter
263
          to avoid numerical issues.
264 Presolve removed 306986 rows and 131227 columns (presolve time = 5s) ...
265 Presolve removed 346399 rows and 131231 columns
266 Presolve time: 5.45s
267 Presolved: 18624 rows, 6374 columns, 77004 nonzeros
268 Variable types: 0 continuous, 6374 integer (6359 binary)
269
270 Root simplex log...
271
272 Iteration Objective
                           Primal Inf. Dual Inf.
                                                  Time
         0 5.5946667e+03 6.260000e+02 0.000000e+00
273
274
       2260 5.5946667e+03 0.000000e+00 0.000000e+00
275
276 Root relaxation: objective 5.594667e+03, 2260 iterations, 0.05 seconds (0.06 work units)
277
278
       Nodes | Current Node | Objective Bounds
                                                          Work
279
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
280
       0 \quad 0 \; 5594.66667 \quad 0 \quad 6
281
                                    - 5594.66667
                        7294.6666667 5594.66667 23.3% - 6s
282 H 0 0
       0 0 5594.66667 0 166 7294.66667 5594.66667 23.3%
283
284
       0 0 5594.66667 0 124 7294.66667 5594.66667 23.3%
                        6814.6666667 5594.66667 17.9% - 6s
285 H 0 0
       0 0 5594.66667 0 104 6814.66667 5594.66667 17.9%
286
287 H 0 0
                       5594.6666667 5594.66667 0.00% - 7s
288
        0 0 5594.66667 0 3 5594.66667 5594.66667 0.00% - 7s
289
290 Cutting planes:
291
     Learned: 1
292
      Gomory: 4
293
      Cover: 190
294
     Implied bound: 401
295
      Clique: 261
296
      MIR: 112
297
      StrongCG: 98
298
      GUB cover: 2
299
      Zero half: 14
300
      RLT: 3
301
      Relax-and-lift: 7
302
303 Explored 1 nodes (14662 simplex iterations) in 7.75 seconds (11.06 work units)
304 Thread count was 8 (of 8 available processors)
305
306 Solution count 3: 5594.67 6814.67 7294.67
307
308 Optimal solution found (tolerance 1.00e-10)
309 Best objective 5.59466666667e+03, best bound 5.59466666667e+03, gap 0.0000%
310 Set parameter MIPGap to value 1e-08
311 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
312
313 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
314 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
315
316 Optimize a model with 252657 rows, 9618 columns and 522313 nonzeros
317 Model fingerprint: 0x176d7c54
318 Variable types: 24 continuous, 9594 integer (5544 binary)
319 Coefficient statistics:
320
      Matrix range [1e-01, 1e+10]
      Objective range [6e-05, 5e+01]
321
      Bounds range [1e+00, 1e+00]
322
323
      RHS range
                   [8e-01, 1e+10]
324 Warning: Model contains large matrix coefficients
325 Warning: Model contains large rhs
326
          Consider reformulating model or setting NumericFocus parameter
327
          to avoid numerical issues.
328 Presolve removed 250097 rows and 8731 columns
329 Presolve time: 0.23s
330 Presolved: 2560 rows, 887 columns, 6934 nonzeros
     Variable types: 0 continuous, 887 integer (512 binary)
```

```
unknown
332
333 Root relaxation: objective 4.582667e+03, 831 iterations, 0.00 seconds (0.01 work units)
334
335
        Nodes | Current Node | Objective Bounds
                                                      Work
336
      Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
337
                         4582.6666667 9662.66667 111% - 0s
338 H 0 0
339
        0 0
                   - 0 4582.66667 4582.66667 0.00% - 0s
340
341 Explored 1 nodes (1127 simplex iterations) in 0.31 seconds (0.46 work units)
342 Thread count was 8 (of 8 available processors)
343
344 Solution count 1: 4582.67
345
346 Optimal solution found (tolerance 1.00e-08)
347 Best objective 4.58266666667e+03, best bound 4.58266666667e+03, gap 0.0000%
348 SP is solved
349 SP's optimal solution is' □4582
350
351 	ext{ Itr} = 2
352 Collect LB = [682.0, 5324.66666666668, 5594.66666666666]
353 Collect_UB = [9727.333333333336, 5554.66666666666, 5424.66666666668]
354 Collect_Hua = [0.0, 4522.6666666668, 4752.66666666666]
355 Collect SPObjVal = [4522.66666666668, 4752.66666666666, 4582.66666666668]
356 Collect MPObjValNHua = [682.0, 802.0, 842.0]
357
358
359
      Ops, stop iteration
      Values adopted from the Itr' th iteration, and Itr = \{2\}, judgeCount = \{2\}
360
361
362
                 ~judge = 2, SPObj SPF = 4582.6666666668
363 Vessel i: 0: pi: 0-5, ai-di: 1-37, gi_SP-gpi_SP: 0.000000-0.000000, ai_SP-di: 1-37, taoi-deltai: 1-34, taoPi_SP-deltaPi_SP: 1-30, betaNi: 33
         bi: 33
                  pi: 5-11, ai-di: 10-30,
     Vessel i: 1:
                                            gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                ai_SP-di: 10-30,
                                                                                                  taoi-deltai: 10-32,
                                                                                                                     taoPi_SP-deltaPi_SP: 10-32,
     : 22, bi: 22
     Vessel i: 2:
                   pi: 16-21,
                                             gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                ai_SP-di: 11-24,
                                                                                                   taoi-deltai: 11-27,
                                                                                                                      taoPi_SP-deltaPi_SP: 11-27,
365
                              ai-di: 11-24,
     betaNi: 16,
                   bi: 16
     Vessel i: 3:
                  pi: 11-16,
                               ai-di: 13-26,
                                             gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                 ai_SP-di: 13-26,
                                                                                                   taoi-deltai: 13-22,
                                                                                                                      taoPi SP-deltaPi SP: 13-22,
     betaNi: 9,
                 bi: 9
     Vessel i: 4:
                   pi: 13-18,
                               ai-di: 38-63,
                                             gi_SP-gpi_SP: 0.200000-1.000000,
                                                                                 ai_SP-di: 39-63,
                                                                                                   taoi-deltai: 39-61,
                                                                                                                      taoPi_SP-deltaPi_SP: 39-61,
     betaNi: 22,
                   bi: 22
368
     Vessel i: 5:
                  pi: 8-13,
                             ai-di: 40-50,
                                            gi SP-gpi SP: 1.000000-0.200000,
                                                                                ai SP-di: 48-50,
                                                                                                                     taoPi SP-deltaPi SP: 48-58,
                                                                                                 taoi-deltai: 48-58.
                                                                                                                                                  betaNi
            bi: 10
     : 10,
369
370 round LB = [682, 5325, 5595]
371 round UB = [9727, 5555, 5425]
372 round Hua = [0, 4523, 4753]
373 round SPObjVal = [4523, 4753, 4583]
374 round MPObjValNHua = [682, 802, 842]
375
376 OptimalObj = 5594.66666666666
377 Time: 66.000000
378
379
380
381
```