```
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=15964
 3
   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 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 457807 rows, 40692 columns and 1261015 nonzeros
19
   Model fingerprint: 0x26b91638
   Variable types: 1 continuous, 40691 integer (40663 binary)
20
21
   Coefficient statistics:
    Matrix range [1e+00, 1e+10]
    Objective range [1e+00, 2e+01]
23
24
    Bounds range [1e+00, 1e+00]
                 [1e+00, 2e+10]
    RHS range
26
   Warning: Model contains large matrix coefficients
27
   Warning: Model contains large rhs
28
        Consider reformulating model or setting NumericFocus parameter
29
        to avoid numerical issues.
   Presolve removed 249913 rows and 15536 columns (presolve time = 5s) ...
30
31
   Presolve removed 409264 rows and 27025 columns
   Presolve time: 9.88s
   Presolved: 48543 rows, 13667 columns, 189280 nonzeros
34
   Variable types: 0 continuous, 13667 integer (13646 binary)
35
   Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
37
   Showing first log only...
38
39
   Root relaxation presolved: 48542 rows, 13668 columns, 189277 nonzeros
40
41
42
   Root simplex log...
43
44
   Iteration Objective
                       Primal Inf. Dual Inf.
       0 9.3400000e+02 1.238750e+02 2.438428e+08
45
                                                    10s
46
   Concurrent spin time: 0.01s
48
   Solved with dual simplex (primal model)
49
50
   Root relaxation: objective 9.340000e+02, 3187 iterations, 0.46 seconds (0.44 work units)
51
52
     Nodes | Current Node | Objective Bounds
                                                Work
53
    Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
54
55
         0 934.00000 0 19
                                - 934.00000
                                - 934 00000
56
     0
         0 934 00000 0 62
                                             - - 11s
57
      0
        0 934.00000 0 67
                               - 934.00000
                      934.0000000 934.00000 0.00% - 15s
58
   H 0 0
59
     0 0 934.00000 0 62 934.00000 934.00000 0.00% - 15s
60
   Cutting planes:
62
    Gomory: 7
63
    Lift-and-project: 1
64
    Cover: 160
    Implied bound: 494
65
66
    Clique: 38
67
    MIR: 88
68
    StrongCG: 23
69
    GUB cover: 26
70
    Zero half: 3
    RLT: 13
    Relax-and-lift: 19
73
    PSD: 1
   Explored 1 nodes (18522 simplex iterations) in 15.37 seconds (19.11 work units)
76
   Thread count was 8 (of 8 available processors)
   Solution count 1: 934
78
79
```

```
80 Optimal solution found (tolerance 1.00e-10)
 81 Best objective 9.34000000000e+02, best bound 9.34000000000e+02, gap 0.0000%
    Set parameter MIPGap to value 1e-08
 83 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
 85 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
 86
 88 Optimize a model with 335528 rows, 11221 columns and 691129 nonzeros
 89 Model fingerprint: 0x177da733
 90 Variable types: 28 continuous, 11193 integer (6468 binary)
 91 Coefficient statistics:
     Matrix range [1e-01, 1e+10]
     Objective range [6e-05, 5e+01]
 93
 94
      Bounds range [1e+00, 1e+00]
                    [8e-01, 1e+10]
     RHS range
     Warning: Model contains large matrix coefficients
 96
     Warning: Model contains large rhs
 97
 98
          Consider reformulating model or setting NumericFocus parameter
 99
          to avoid numerical issues.
100 Presolve removed 331088 rows and 9695 columns
101 Presolve time: 0.39s
102 Presolved: 4440 rows, 1526 columns, 11883 nonzeros
103 Variable types: 6 continuous, 1520 integer (899 binary)
104 Found heuristic solution: objective 4826.5486169
105
106 Root relaxation: objective 6.398549e+03, 1410 iterations, 0.03 seconds (0.02 work units)
107
108
       Nodes | Current Node | Objective Bounds
109 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
110
111 *
                     0 6398.5486169 6398.54862 0.00% - 0s
112
113 Explored 1 nodes (1842 simplex iterations) in 0.52 seconds (0.66 work units)
114 Thread count was 8 (of 8 available processors)
115
116 Solution count 2: 6398.55 4826.55
117
118 Optimal solution found (tolerance 1.00e-08)
119 Best objective 6.398548616906e+03, best bound 6.398548616906e+03, gap 0.0000%
120 SP is solved
121 SP's optimal solution is' ☐ 6398
122
123 Itr = 0
124 Collect_LB = [934.0]
125 Collect_UB = [13731.097233811932]
126 Collect_Hua = [0.0]
127 Collect_SPObjVal = [6398.548616905966]
128 Collect MPObjValNHua = [934.0]
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 462051 rows, 180636 columns and 1265280 nonzeros
138 Model fingerprint: 0x0d308996
139 Variable types: 1 continuous, 180635 integer (180607 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 286355 rows and 160742 columns (presolve time = 5s) ...
150 Presolve removed 438280 rows and 172449 columns
151 Presolve time: 9.39s
152
    Presolved: 23771 rows, 8187 columns, 100931 nonzeros
153 Variable types: 0 continuous, 8187 integer (8168 binary)
154
155 Root simplex log...
156
157 Iteration Objective
                           Primal Inf. Dual Inf.
                                                   Time
         0 7.3845486e+03 9.987500e+02 0.000000e+00
158
159
       3567 7.3845486e+03 0.000000e+00 0.000000e+00 10s
160
Root relaxation: objective 7.384549e+03, 3567 iterations, 0.08 seconds (0.10 work units)
162
                  Current Node
                                   Objective Bounds
163
       Nodes
```

```
164 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
165
           0.7384.54862 0 25
                                    - 7384.54862
166
167
       0
           0 7384.54862 0 26
                                    - 7384.54862
                                                         98
           0 7384.54862 0 62
                                    - 7384.54862
                                                      - 11s
168
169
       0
           0 7384.54862 0 132
                                    - 7384.54862
                                                      - 11s
           0.7384.54862 \quad 0.126
                                                   - - 11s
170
                                    - 7384.54862
       0
171 H 0 0
                       8464.5486169 7384.54862 12.8% - 14s
           0 7384.54862 0 111 8464.54862 7384.54862 12.8%
                                                              - 15s
172
           0 7384.54862 0 110 8464.54862 7384.54862 12.8%
173
       0
                                                              - 15s
           0 7384.54862 0 468 8464.54862 7384.54862 12.8%
174
       0
                                                               - 17s
175
       0
           0 7384.54862 0 305 8464.54862 7384.54862 12.8%
                                                              - 17s
          0 7384.54862 0 269 8464.54862 7384.54862 12.8% - 18s
176
       0
                        7384.5486169 7384.54862 0.00% - 20s
177 H 0 0
178
       0 0 7384.54862 0 60 7384.54862 7384.54862 0.00%
                                                              - 20s
179
180 Cutting planes:
181
     Learned: 1
182
     Gomory: 3
183
     Lift-and-project: 1
184
      Cover: 116
185
      Implied bound: 662
      Clique: 1865
186
187
      MIR: 178
      StrongCG: 140
188
189
      GUB cover: 12
      Zero half: 13
190
191
      RLT: 11
192
      Relax-and-lift: 25
193
      BQP: 26
194
      PSD: 5
195
196 Explored 1 nodes (50235 simplex iterations) in 20.99 seconds (26.07 work units)
197 Thread count was 8 (of 8 available processors)
198
199 Solution count 2: 7384.55 8464.55
200
201 Optimal solution found (tolerance 1.00e-10)
202 Best objective 7.384548616906e+03, best bound 7.384548616906e+03, gap 0.0000%
203 Set parameter MIPGap to value 1e-08
204 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
205
206 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
207 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
208
209 Optimize a model with 335528 rows, 11221 columns and 691129 nonzeros
210 Model fingerprint: 0xebc5c2a5
211 Variable types: 28 continuous, 11193 integer (6468 binary)
212 Coefficient statistics:
     Matrix range [1e-01, 1e+10]
213
214
     Objective range [6e-05, 5e+01]
     Bounds range [1e+00, 1e+00]
                   [8e-01, 1e+10]
216
     RHS range
    Warning: Model contains large matrix coefficients
217
218 Warning: Model contains large rhs
         Consider reformulating model or setting NumericFocus parameter
219
220
         to avoid numerical issues.
221 Presolve removed 329101 rows and 9093 columns
222 Presolve time: 0.28s
223 Presolved: 6427 rows, 2128 columns, 17197 nonzeros
224 Variable types: 6 continuous, 2122 integer (1228 binary)
225 Found heuristic solution: objective 4691.9988688
226
227 Root relaxation: objective 6.867000e+03, 1863 iterations, 0.03 seconds (0.02 work units)
228
229
       Nodes | Current Node | Objective Bounds
230 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
231
       0 \quad 0.6867.00000 \quad 0 \quad 29.4691.99887.6867.00000 \quad 46.4\%
232
233 H 0
                       6634.8523388 6867.00000 3.50% - 0s
234
       0 0 6867.00000 0 16 6634.85234 6867.00000 3.50% - 0s
235
       0 0 6867.00000 0 12 6634.85234 6867.00000 3.50% - 0s
236 H 0 0
                        6679.0000000 6867.00000 2.81% - 0s
                        6866.9634499 6867.00000 0.00%
237 H
238
       0 0 6867.00000 0 4 6866.96345 6867.00000 0.00%
                                                                0s
239 H 0
            0
                        6867.0000000 6867.00000 0.00%
240
241 Explored 1 nodes (3305 simplex iterations) in 0.54 seconds (0.71 work units)
242 Thread count was 8 (of 8 available processors)
243
244 Solution count 5: 6867 6866.96 6679 ... 4692
245
246 Optimal solution found (tolerance 1.00e-08)
247 Best objective 6.867000000000e+03, best bound 6.86700000000e+03, gap 0.0000%
```

```
248 SP is solved
249 SP's optimal solution is' □ 6867
250
251 Itr = 1
252 Collect LB = [934.0, 7384.548616905966]
253 Collect_UB = [13731.097233811932, 7853.00000000000004]
254 Collect_Hua = [0.0, 6398.548616905966]
255 Collect_SPObjVal = [6398.548616905966, 6867.000000000000004]
256 Collect MPObjValNHua = [934.0, 986.0]
257
258
259 Set parameter MIPGap to value 1e-10
260 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
261
262 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
263 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
264
265 Optimize a model with 462051 rows, 180636 columns and 1265280 nonzeros
266 Model fingerprint: 0xa78d7359
267
    Variable types: 1 continuous, 180635 integer (180607 binary)
268 Coefficient statistics:
      Matrix range [1e+00, 1e+10]
269
270
      Objective range [1e+00, 2e+01]
      Bounds range [1e+00, 1e+00]
271
     RHS range
                   [1e+00, 2e+10]
272
273
     Warning: Model contains large matrix coefficients
274 Warning: Model contains large rhs
          Consider reformulating model or setting NumericFocus parameter
275
276
          to avoid numerical issues.
277 Presolve removed 286355 rows and 160742 columns (presolve time = 6s) ...
278 Presolve removed 286355 rows and 160742 columns (presolve time = 10s) ...
279 Presolve removed 438280 rows and 172449 columns
280 Presolve time: 12.38s
281 Presolved: 23771 rows, 8187 columns, 100931 nonzeros
282 Variable types: 0 continuous, 8187 integer (8168 binary)
283
284 Root simplex log...
285
286 Iteration Objective
                           Primal Inf. Dual Inf.
                                                  Time
         0 7.8530000e+03 9.987500e+02 0.000000e+00 13s
287
288
       3567 7.8530000e+03 0.000000e+00 0.000000e+00 13s
289
290 Root relaxation: objective 7.853000e+03, 3567 iterations, 0.08 seconds (0.10 work units)
291
292
       Nodes | Current Node | Objective Bounds | Work
293
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
294
295
           0.7853.00000 \quad 0 \quad 25
                                    - 7853.00000
296
       0
           0 7853.00000 0 26
                                    - 7853.00000
                                                      - 12s
297
           0.7853.00000 0 62
                                    - 7853.00000
                                                   - - 14s
       0
298
       0
           0 7853.00000 0 132
                                    - 7853.00000
                                                       - 14s
299
           0.7853.00000 \quad 0.126
                                    - 7853.00000
300 H 0 0
                       8933.0000000 7853.00000 12.1%
           0 7853.00000 0 111 8933.00000 7853.00000 12.1%
301
302
           0 7853.00000 0 110 8933.00000 7853.00000 12.1%
           0 7853.00000 0 468 8933.00000 7853.00000 12.1%
303
                                                                  2.0s
                                                              - 21s
           0 7853.00000 0 305 8933.00000 7853.00000 12.1%
304
       0
           0.7853.00000 \quad 0.269.8933.00000.7853.00000.12.1\%
305
       0
                                                               - 21s
306 H 0 0
                        7853.0000000 7853.00000 0.00% - 24s
           307
308
309 Cutting planes:
310 Learned: 1
311
     Gomory: 3
312
     Lift-and-project: 1
313
      Cover: 116
314
      Implied bound: 662
315
     Clique: 1865
316
      MIR: 178
      StrongCG: 140
317
     GUB cover: 12
318
319
      Zero half: 13
320
      RLT: 11
321
      Relax-and-lift: 25
322
      BQP: 26
323
      PSD: 5
324
325 Explored 1 nodes (50235 simplex iterations) in 24.39 seconds (26.07 work units)
326
    Thread count was 8 (of 8 available processors)
327
328
    Solution count 2: 7853 8933
329
330 Optimal solution found (tolerance 1.00e-10)
331 Best objective 7.853000000000e+03, best bound 7.85300000000e+03, gap 0.0000%
```

```
Set parameter MIPGap to value 1e-08
332
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 335528 rows, 11221 columns and 691129 nonzeros
339 Model fingerprint: 0xebc5c2a5
340 Variable types: 28 continuous, 11193 integer (6468 binary)
341 Coefficient statistics:
342
      Matrix range [1e-01, 1e+10]
343
      Objective range [6e-05, 5e+01]
344
      Bounds range [1e+00, 1e+00]
                    [8e-01, 1e+10]
345
      RHS range
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 329101 rows and 9093 columns
351 Presolve time: 0.27s
    Presolved: 6427 rows, 2128 columns, 17197 nonzeros
352
353 Variable types: 6 continuous, 2122 integer (1228 binary)
354 Found heuristic solution: objective 4691.9988688
355
356 Root relaxation: objective 6.867000e+03, 1863 iterations, 0.02 seconds (0.02 work units)
357
358
       Nodes | Current Node | Objective Bounds
359
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
360
           0 6867.00000 0 29 4691.99887 6867.00000 46.4%
361
362 H 0 0
                         6634.8523388 6867.00000 3.50%
       0 0 6867,00000 0 16 6634,85234 6867,00000 3,50% -
363
                                                                    0s
364
           0.6867.00000 \quad 0 \quad 12.6634.85234.6867.00000 \quad 3.50\%
        0
                         6679.0000000 6867.00000 2.81% - 0s
365 H 0
366 H 0
                         6866.9634499 6867.00000 0.00%
            0
       0 0 6867.00000 0 4 6866.96345 6867.00000 0.00%
367
                                                                   0s
368 H
        0
                         6867.0000000 6867.00000 0.00%
369
370 Explored 1 nodes (3305 simplex iterations) in 0.52 seconds (0.71 work units)
371
    Thread count was 8 (of 8 available processors)
372
    Solution count 5: 6867 6866.96 6679 ... 4692
373
374
375 Optimal solution found (tolerance 1.00e-08)
376 Best objective 6.867000000000e+03, best bound 6.86700000000e+03, gap 0.0000%
377 SP is solved
378 SP's optimal solution is' ☐ 6867
379
380 Itr = 2
381 Collect LB = [934.0, 7384.548616905966, 7853.00000000000004]
382 Collect UB = [13731.097233811932, 7853.000000000004, 7853.0000000000004]
383 Collect_Hua = [0.0, 6398.548616905966, 6867.000000000000004]
384 Collect SPObjVal = [6398.548616905966, 6867.000000000004, 6867.00000000000004]
385 Collect_MPObjValNHua = [934.0, 986.0, 986.0]
386
387
388
      Reach the termination conditions, stop iteration
389
     Values adopted from the Itr' th iteration, and Itr = \{2\}, judgeCount = \{2\}
390
391
                 \simjudge = 2, SPObj SPF = 6867.000000000004
                  pi: 0-7, ai-di: 1-33, gi_SP-gpi_SP: 0.000000-0.000000,
392
    Vessel i: 0:
                                                                              ai SP-di: 1-33, taoi-deltai: 1-32, taoPi SP-deltaPi SP: 1-32,
                                                                                                                                              betaNi: 31
         bi: 31
393
     Vessel i: 1:
                  pi: 8-13, ai-di: 5-33,
                                           gi SP-gpi SP: 0.000000-0.000000,
                                                                               ai SP-di: 5-33,
                                                                                                taoi-deltai: 5-31,
                                                                                                                    taoPi SP-deltaPi SP: 5-31, betaNi: 26
         bi: 26
     Vessel i: 2:
                  pi: 13-18,
                               ai-di: 7-24,
                                            gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                 ai_SP-di: 7-24,
                                                                                                  taoi-deltai: 7-22, taoPi_SP-deltaPi_SP: 7-22,
                                                                                                                                                 betaNi: 15
         bi: 15
                                                                                  ai_SP-di: 13-50,
     Vessel i: 3:
                   pi: 20-27,
                                                                                                                        taoPi SP-deltaPi SP: 13-48,
                               ai-di: 13-50.
                                             gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                                    taoi-deltai: 13-48.
                   hi: 35
     betaNi: 35.
396
     Vessel i: 4:
                   pi: 13-19,
                               ai-di: 26-40,
                                              gi SP-gpi SP: 0.000000-0.400000,
                                                                                  ai SP-di: 26-40,
                                                                                                    taoi-deltai: 26-38,
                                                                                                                        taoPi SP-deltaPi SP: 26-38,
     betaNi: 12,
                   bi: 12
     Vessel i: 5:
                  pi: 10-15.
                               ai-di: 32-48.
                                              gi_SP-gpi_SP: 0.800000-0.800000,
                                                                                  ai_SP-di: 38-48,
                                                                                                    taoi-deltai: 39-50.
                                                                                                                        taoPi_SP-deltaPi_SP: 40-50,
     betaNi: 11,
                  bi: 11
                   pi: 15-20,
                                              gi_SP-gpi_SP: 1.000000-0.600000,
                               ai-di: 40-78,
                                                                                  ai SP-di: 50-78,
                                                                                                    taoi-deltai: 50-78,
                                                                                                                        taoPi SP-deltaPi SP: 50-78,
     Vessel i: 6:
     betaNi: 28,
                  bi: 28
399
400 round LB = [934, 7385, 7853]
401 round UB = [13731, 7853, 7853]
402 round Hua = [0, 6399, 6867]
403 round SPObjVal = [6399, 6867, 6867]
404 round MPObjValNHua = [934, 986, 986]
405
406 OptimalObj = 7853.000000000004
407 Time: 119.000000
408
```

unknown			
409 410 411			
411			