```
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=52746
   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')
10 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 375969 rows, 34789 columns and 1042007 nonzeros
19
   Model fingerprint: 0x36dd4b10
   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 326897 rows and 23704 columns
31
   Presolve time: 4.77s
   Presolved: 49072 rows, 11085 columns, 174856 nonzeros
33
   Variable types: 0 continuous, 11085 integer (11070 binary)
34
35
   Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
   Showing first log only...
37
38
   Root relaxation presolved: 49072 rows, 11085 columns, 174856 nonzeros
39
40
   Concurrent spin time: 0.02s
41
42
   Solved with dual simplex (primal model)
43
44
   Root relaxation: objective 6.660000e+02, 1309 iterations, 0.17 seconds (0.16 work units)
45
46
     Nodes | Current Node | Objective Bounds
47
    Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
48
      0 \quad 0 \ 666.00000 \quad 0 \quad 3
49
                                 - 666.00000
                       1106.0000000 666.00000 39.8%
50 H 0 0
51 H 0
                       666.0000000 666.00000 0.00%
52
53
   Cutting planes:
54
    Gomory: 1
55
    Cover: 1
    StrongCG: 1
56
57
    GUB cover: 1
58
    RLT: 2
59
60
   Explored 1 nodes (2694 simplex iterations) in 5.73 seconds (10.09 work units)
   Thread count was 8 (of 8 available processors)
62
   Solution count 2: 666 1106
63
64
65
   Optimal solution found (tolerance 1.00e-10)
   Best objective 6.660000000000e+02, best bound 6.66000000000e+02, gap 0.0000%
66
67
   Set parameter MIPGap to value 1e-08
   Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
68
70 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
73
   Optimize a model with 252589 rows, 9618 columns and 522109 nonzeros
   Model fingerprint: 0xc369ab6c
74
   Variable types: 24 continuous, 9594 integer (5544 binary)
76
   Coefficient statistics:
    Matrix range [1e-01, 1e+10]
78
    Objective range [6e-05, 5e+01]
                  [1e+00, 1e+00]
79
    Bounds range
```

```
RHS range
                   [8e-01, 1e+10]
 80
    Warning: Model contains large matrix coefficients
    Warning: Model contains large rhs
 82
 83
         Consider reformulating model or setting NumericFocus parameter
         to avoid numerical issues.
 85 Presolve removed 251162 rows and 9135 columns
 86 Presolve time: 0.22s
 87 Presolved: 1427 rows, 483 columns, 3802 nonzeros
    Variable types: 0 continuous, 483 integer (274 binary)
 89 Found heuristic solution: objective 2803.6666667
 90
 91
    Root relaxation: objective 3.220667e+03, 293 iterations, 0.00 seconds (0.00 work units)
 92
 93
      Nodes | Current Node | Objective Bounds
                                                    Work
 94
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
                        3220.6666667 6180.66667 91.9% - 0s
 96 H 0 0
 97
                 - 0
                       3220.66667 3220.66667 0.00% - 0s
       0 0
 98
 99 Explored 1 nodes (445 simplex iterations) in 0.31 seconds (0.42 work units)
100 Thread count was 8 (of 8 available processors)
101
102 Solution count 2: 3220.67 2803.67
103
104 Optimal solution found (tolerance 1.00e-08)
105 Best objective 3.220666666667e+03, best bound 3.220666666667e+03, gap 0.0000%
106 SP is solved
107 SP's optimal solution is' □ 3220
108
109 	ext{ Itr} = 0
110 Collect LB = [666.0]
111 Collect_UB = [7107.3333333333333]
112 Collect_Hua = [0.0]
113 Collect_SPObjVal = [3220.66666666668]
114 Collect MPObjValNHua = [666.0]
115
116
117 Set parameter MIPGap to value 1e-10
118 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
119
120 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
121 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
122
123 Optimize a model with 382144 rows, 137605 columns and 1048197 nonzeros
124 Model fingerprint: 0x4d868613
125 Variable types: 1 continuous, 137604 integer (137580 binary)
126 Coefficient statistics:
127
     Matrix range [1e+00, 1e+10]
128 Objective range [1e+00, 2e+01]
     Bounds range [1e+00, 1e+00]
129
130
     RHS range
                   [1e+00, 2e+10]
131 Warning: Model contains large matrix coefficients
132 Warning: Model contains large rhs
133
         Consider reformulating model or setting NumericFocus parameter
134
         to avoid numerical issues.
135 Presolve removed 355840 rows and 133024 columns
136 Presolve time: 4.28s
137 Presolved: 26304 rows, 4581 columns, 69310 nonzeros
138
    Variable types: 0 continuous, 4581 integer (4566 binary)
139 Root relaxation presolved: 4581 rows, 30885 columns, 73891 nonzeros
140
141
Root relaxation: objective 4.066667e+03, 3466 iterations, 0.23 seconds (0.33 work units)
143
       Nodes | Current Node | Objective Bounds | Work
144
145
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
146
       0 0 4066.66667 0 7
147
                                   - 4066 66667
148
       0
          0 4066.66667 0 169
                                   - 4066.66667
149
           0\ 4066.66667\quad 0\ 162
                                    - 4066.66667
       0
150 H 0 0
                       4146.6666667 4066.66667 1.93%
       151
152
       0
           0 4066.66667 0 102 4146.66667 4066.66667 1.93% -
       0 0 4066.66667 0 63 4146.66667 4066.66667 1.93%
153
154 H 0 0
                       4066.6666667 4066.66667 0.00% - 5s
155
156 Cutting planes:
157
     Cover: 105
     Implied bound: 660
158
159
     Clique: 25
160
     MIR: 8
     StrongCG: 2
161
162
     GUB cover: 6
     Zero half: 3
163
```

```
164
     RLT: 1
165
     Relax-and-lift: 49
166
167 Explored 1 nodes (7800 simplex iterations) in 5.86 seconds (9.60 work units)
168 Thread count was 8 (of 8 available processors)
169
170 Solution count 2: 4066.67 4146.67
171
172 Optimal solution found (tolerance 1.00e-10)
173 Best objective 4.0666666666667e+03, best bound 4.06666666667e+03, gap 0.0000%
174 Set parameter MIPGap to value 1e-08
175 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
176
177 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
178 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
180 Optimize a model with 252589 rows, 9618 columns and 522109 nonzeros
181 Model fingerprint: 0x78b57276
182 Variable types: 24 continuous, 9594 integer (5544 binary)
183 Coefficient statistics:
     Matrix range [1e-01, 1e+10]
184
185
     Objective range [6e-05, 5e+01]
     Bounds range [1e+00, 1e+00]
186
187
     RHS range
                    [8e-01, 1e+10]
188 Warning: Model contains large matrix coefficients
189
    Warning: Model contains large rhs
          Consider reformulating model or setting NumericFocus parameter
190
          to avoid numerical issues.
191
192 Presolve removed 251008 rows and 9039 columns
193 Presolve time: 0.19s
194 Presolved: 1581 rows, 579 columns, 4212 nonzeros
195 Variable types: 4 continuous, 575 integer (337 binary)
196 Found heuristic solution: objective 2624.3818887
197
198 Root relaxation: objective 3.444667e+03, 417 iterations, 0.00 seconds (0.00 work units)
199
200
       Nodes | Current Node | Objective Bounds
                                                          Work
201
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
202
                         3444.6666667 6522.00000 89.3% - 0s
203 H 0 0
204
                  - 0
                         3444.66667 3444.66667 0.00% - 0s
205
206 Explored 1 nodes (569 simplex iterations) in 0.27 seconds (0.36 work units)
207 Thread count was 8 (of 8 available processors)
208
209 Solution count 2: 3444.67 2624.38
210
211 Optimal solution found (tolerance 1.00e-08)
212 Best objective 3.444666666667e+03, best bound 3.44466666667e+03, gap 0.0000%
213 SP is solved
214 SP's optimal solution is' □ 3444
215
216 Itr = 1
217 Collect LB = [666.0, 4066.66666666668]
218 Collect_UB = [7107.33333333336, 4290.66666666668]
219 Collect Hua = [0.0, 3220.6666666668]
220 Collect SPObjVal = [3220.66666666668, 3444.66666666668]
221 Collect_MPObjValNHua = [666.0, 846.0]
222
223
224 Set parameter MIPGap to value 1e-10
225 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
226
227 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
228 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
229
230 Optimize a model with 382144 rows, 137605 columns and 1048197 nonzeros
231 Model fingerprint: 0xcf2e1b6c
232 Variable types: 1 continuous, 137604 integer (137580 binary)
233 Coefficient statistics:
234 Matrix range [1e+00, 1e+10]
235
     Objective range [1e+00, 2e+01]
236
     Bounds range [1e+00, 1e+00]
                    [1e+00, 2e+10]
237
     RHS range
238
    Warning: Model contains large matrix coefficients
    Warning: Model contains large rhs
239
240
          Consider reformulating model or setting NumericFocus parameter
241
          to avoid numerical issues.
242 Presolve removed 355840 rows and 133024 columns
243 Presolve time: 4.39s
244 Presolved: 26304 rows, 4581 columns, 69310 nonzeros
245 Variable types: 0 continuous, 4581 integer (4566 binary)
246 Root relaxation presolved: 4581 rows, 30885 columns, 73891 nonzeros
247
```

```
248
249 Root relaxation: objective 4.290667e+03, 3466 iterations, 0.19 seconds (0.33 work units)
250
251
       Nodes | Current Node | Objective Bounds | Work
     Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
253
254
       0 0 4290.66667 0 7
                                   - 4290.66667
255
       0
           0.4290.66667 \quad 0.169
                                    - 4290.66667 - - 5s
                                                   - - 5s
                                    - 4290.66667
256
       0
           0 4290.66667 0 162
                       4370,6666667 4290,66667 1.83%
257 H 0 0
       0 0 4290.66667 0 99 4370.66667 4290.66667 1.83%
258
259
           0 4290.66667 0 102 4370.66667 4290.66667 1.83% -
       0 0 4290.66667 0 63 4370.66667 4290.66667 1.83% -
260
261 H 0 0
                        4290.6666667 4290.66667 0.00% - 5s
262
263 Cutting planes:
264
      Cover: 105
     Implied bound: 660
265
266
     Clique: 25
267
      MIR: 8
268
      StrongCG: 2
269
      GUB cover: 6
270
      Zero half: 3
271
      RLT: 1
272
      Relax-and-lift: 49
273
274 Explored 1 nodes (7800 simplex iterations) in 5.84 seconds (9.60 work units)
275 Thread count was 8 (of 8 available processors)
276
277 Solution count 2: 4290.67 4370.67
278
279 Optimal solution found (tolerance 1.00e-10)
280 Best objective 4.290666666667e+03, best bound 4.290666666667e+03, gap 0.0000%
     Set parameter MIPGap to value 1e-08
282 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
283
284 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
285 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
286
287 Optimize a model with 252589 rows, 9618 columns and 522109 nonzeros
288 Model fingerprint: 0x78b57276
289 Variable types: 24 continuous, 9594 integer (5544 binary)
290 Coefficient statistics:
291
     Matrix range [1e-01, 1e+10]
292
      Objective range [6e-05, 5e+01]
     Bounds range [1e+00, 1e+00]
293
                   [8e-01, 1e+10]
294
     RHS range
295
     Warning: Model contains large matrix coefficients
296 Warning: Model contains large rhs
297
          Consider reformulating model or setting NumericFocus parameter
298
          to avoid numerical issues.
299 Presolve removed 251008 rows and 9039 columns
300 Presolve time: 0.19s
301 Presolved: 1581 rows, 579 columns, 4212 nonzeros
302 Variable types: 4 continuous, 575 integer (337 binary)
303 Found heuristic solution: objective 2624.3818887
304
305 Root relaxation: objective 3.444667e+03, 417 iterations, 0.02 seconds (0.00 work units)
306
307
       Nodes | Current Node | Objective Bounds
308 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
309
                        3444.6666667 6522.00000 89.3% - 0s
310 H 0 0
311
       0 0
                  - 0
                        3444.66667 3444.66667 0.00% - 0s
312
313 Explored 1 nodes (569 simplex iterations) in 0.28 seconds (0.36 work units)
314 Thread count was 8 (of 8 available processors)
315
316 Solution count 2: 3444.67 2624.38
317
318 Optimal solution found (tolerance 1.00e-08)
319 Best objective 3.444666666667e+03, best bound 3.44466666667e+03, gap 0.0000%
320 SP is solved
321 SP's optimal solution is' □ 3444
322
323 Itr = 2
324 Collect LB = [666.0, 4066.6666666668, 4290.66666666668]
325 Collect_UB = [7107.333333333336, 4290.666666666668, 4290.66666666668]
326 Collect Hua = [0.0, 3220.6666666668, 3444.66666666668]
327 Collect SPObjVal = [3220.66666666668, 3444.666666668, 3444.6666666668]
328 Collect MPObjValNHua = [666.0, 846.0, 846.0]
329
330
      Reach the termination conditions, stop iteration
331
```

```
unknown
332
      Values adopted from the Itr' th iteration, and Itr = \{2\}, judgeCount = \{2\}
333
               ---judge = 2, SPObj_SPF = 3444.66666666668
334
335 Vessel i: 0:
                   pi: 0-6, ai-di: 2-23, gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                 ai_SP-di: 2-23, taoi-deltai: 2-25,
                                                                                                                     taoPi_SP-deltaPi_SP: 2-21, betaNi: 23
         bi: 23
336
     Vessel i: 1:
                   pi: 6-13, ai-di: 8-17, gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                  ai SP-di: 8-17, taoi-deltai: 8-16,
                                                                                                                       taoPi SP-deltaPi SP: 8-16, betaNi: 8
         bi: 8
337 Vessel i: 2:
                   pi: 3-10,
                               ai-di: 34-42,
                                              gi_SP-gpi_SP: 0.000000-0.000000,
                                                                                   ai_SP-di: 34-42,
                                                                                                      taoi-deltai: 34-41,
                                                                                                                          taoPi_SP-deltaPi_SP: 34-39,
                                                                                                                                                         betaNi
      : 7, bi: 7
                                               gi_SP-gpi_SP: 0.000000-0.000000,
     Vessel i: 3:
                    pi: 12-19,
                                ai-di: 40-58,
                                                                                                                           taoPi_SP-deltaPi_SP: 40-56,
                                                                                    ai_SP-di: 40-58,
                                                                                                       taoi-deltai: 40-56,
     betaNi: 16,
                   bi: 16
     Vessel i: 4:
                   pi: 6-12,
                               ai-di: 47-59,
                                              gi_SP-gpi_SP: 0.200000-1.000000,
                                                                                   ai_SP-di: 48-59,
                                                                                                      taoi-deltai: 48-61,
                                                                                                                          taoPi_SP-deltaPi_SP: 48-61,
     : 13, bi: 13
340 Vessel i: 5:
                   pi: 27-34,
                                              gi_SP-gpi_SP: 1.000000-0.200000,
                                                                                    ai_SP-di: 58-67,
                                                                                                                          taoPi_SP-deltaPi_SP: 58-77,
                                ai-di: 50-67,
                                                                                                       taoi-deltai: 58-77,
     betaNi: 19,
                   bi: 19
342 round LB = [666, 4067, 4291]
343 round UB = [7107, 4291, 4291]
344 round Hua = [0, 3221, 3445]
345 round SPObjVal = [3221, 3445, 3445]
346 round MPObjValNHua = [666, 846, 846]
347
348 OptimalObj = 4290.6666666668
349 Time: 63.000000
350
351
352
353
```