```
 1  "E:\1 □□□□\3 □□□□□\1 □□□□□□\1 □□□□□□□□\1_□□□□□□_□□□□\1_LW_□□□□□\4 □□□□□\3 python_code\1 exzample\2 □□□□□□□\9 Code for
    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=56915

 3  import sys; print('Python %s on %s' % (sys.version, sys.platform))
 4  sys.path.extend(['E:\\1 □□□□\\3 □□□□□\\1 □□□□□□\\1 □□□□□□□□\\1_□□□□□□_□□□□\\1_LW_□□□□□\\4 □□□□□\\3 python_code\\9 Code for this
    paper', 'E:/1 □□□□/3 □□□□□/1 □□□□□□/1 □□□□□□□□/1_□□□□□□_□□□□/1_LW_□□□□□/4 □□□□□/3 python_code/9 Code for this paper'])

 6  PyDev console: starting.

 8  Python 3.9.7 (tags/v3.9.7:1016ef3, Aug 30 2021, 20:19:38) [MSC v.1929 64 bit (AMD64)] on win32
 9  >>> runfile('E:/1 □□□□/3 □□□□□/1 □□□□□□/1 □□□□□□□□/1_□□□□□□_□□□□/1_LW_□□□□□/4 □□□□□/3 python_code/9 Code for this paper/
    main_RO_CCG.py', wdir='E:/1 □□□□/3 □□□□□/1 □□□□□□/1 □□□□□□□□/1_□□□□□□_□□□□/1_LW_□□□□□/4 □□□□□/3 python_code/9 Code for
    this paper')
10  Backend TkAgg is interactive backend. Turning interactive mode on.
11  Waiting 5s......
12  Set parameter MIPGap to value 1e-10
13  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)

15  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
16  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads

18  Optimize a model with 361160 rows, 34789 columns and 995570 nonzeros
19  Model fingerprint: 0xd26ac180
20  Variable types: 1 continuous, 34788 integer (34764 binary)
21  Coefficient statistics:
22    Matrix range     [1e+00, 1e+10]
23    Objective range  [1e+00, 2e+01]
24    Bounds range     [1e+00, 1e+00]
25    RHS range        [1e+00, 2e+10]
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
31  Presolve time: 4.94s
32  Presolved: 41022 rows, 10797 columns, 146176 nonzeros
33  Variable types: 0 continuous, 10797 integer (10782 binary)

35  Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
36  Showing first log only...

38  Root relaxation presolved: 41022 rows, 10797 columns, 146176 nonzeros


41  Root simplex log...

43  Iteration    Objective       Primal Inf.    Dual Inf.      Time
44       0    1.2020000e+03   5.150000e+01   8.888983e+07      5s
45  Concurrent spin time: 0.00s

47  Solved with dual simplex (primal model)

49  Root relaxation: objective 6.820000e+02, 1686 iterations, 0.16 seconds (0.15 work units)

51     Nodes    |    Current Node    |     Objective Bounds     |     Work
52   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time

54       0     0  682.00000    0    8          -  682.00000      -     -    5s
55  H    0     0                    1622.0000000  682.00000  58.0%     -    5s
56       0     0  682.00000    0  133 1622.00000  682.00000  58.0%     -    5s
57       0     0  682.00000    0  132 1622.00000  682.00000  58.0%     -    5s
58  H    0     0                    1202.0000000  682.00000  43.3%     -    6s
59  H    0     0                    682.0000000  682.00000   0.00%     -    6s

61  Cutting planes:
62    Gomory: 1
63    Cover: 23
64    Implied bound: 474
65    Clique: 1
66    MIR: 7
67    GUB cover: 4
68    RLT: 1
69    Relax-and-lift: 4
70    BQP: 1

72  Explored 1 nodes (4505 simplex iterations) in 6.71 seconds (11.33 work units)
73  Thread count was 8 (of 8 available processors)

75  Solution count 3: 682 1202 1622

77  Optimal solution found (tolerance 1.00e-10)
78  Best objective 6.820000000000e+02, best bound 6.820000000000e+02, gap 0.0000%
79  Set parameter MIPGap to value 1e-08
```

```
 80   Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
 81
 82   CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
 83   Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
 84
 85   Optimize a model with 1153828 rows, 901813 columns and 7829795 nonzeros
 86   Model fingerprint: 0x44d2dd13
 87   Variable types: 441325 continuous, 460488 integer (456438 binary)
 88   Coefficient statistics:
 89     Matrix range     [1e-01, 1e+10]
 90     Objective range  [6e-05, 5e+01]
 91     Bounds range     [1e+00, 8e+01]
 92     RHS range        [8e-01, 1e+10]
 93   Warning: Model contains large matrix coefficients
 94   Warning: Model contains large rhs
 95        Consider reformulating model or setting NumericFocus parameter
 96        to avoid numerical issues.
 97   Presolve removed 1151379 rows and 900916 columns
 98   Presolve time: 2.47s
 99   Presolved: 2449 rows, 897 columns, 6631 nonzeros
100   Variable types: 0 continuous, 897 integer (507 binary)
101   Found heuristic solution: objective 3134.6666667
102   Found heuristic solution: objective 3194.6666667
103
104   Root relaxation: objective 4.522667e+03, 799 iterations, 0.00 seconds (0.01 work units)
105
106       Nodes    |    Current Node    |     Objective Bounds     |     Work
107    Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
108
109   H    0    0                    4522.6666667 9482.66667  110%    -    3s
110        0    0          -    0     4522.66667 4522.66667  0.00%    -    3s
111
112   Explored 1 nodes (1042 simplex iterations) in 3.30 seconds (3.47 work units)
113   Thread count was 8 (of 8 available processors)
114
115   Solution count 3: 4522.67 3194.67 3134.67
116
117   Optimal solution found (tolerance 1.00e-08)
118   Best objective 4.522666666667e+03, best bound 4.522666666667e+03, gap 0.0000%
119   SP is solved
120   SP's optimal solution is' 4522
121
122    Itr = 0
123   Collect_LB =  [682.0]
124   Collect_UB =  [9727.333333333332]
125   Collect_Hua =  [0.0]
126   Collect_SPObjVal =  [4522.666666666666]
127   Collect_MPObjValNHua =  [682.0]
128
129
130   Set parameter MIPGap to value 0.05
131   Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
132
133   CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
134   Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
135
136   Optimize a model with 617649 rows, 150727 columns and 1816556 nonzeros
137   Model fingerprint: 0xdba43eca
138   Variable types: 1 continuous, 150726 integer (143124 binary)
139   Coefficient statistics:
140     Matrix range     [1e-01, 1e+10]
141     Objective range  [1e+00, 2e+01]
142     Bounds range     [1e+00, 1e+00]
143     RHS range        [1e+00, 2e+10]
144   Warning: Model contains large matrix coefficients
145   Warning: Model contains large rhs
146        Consider reformulating model or setting NumericFocus parameter
147        to avoid numerical issues.
148   Presolve removed 494748 rows and 133532 columns (presolve time = 5s) ...
149   Presolve removed 552593 rows and 140369 columns
150   Presolve time: 9.18s
151   Presolved: 65056 rows, 10358 columns, 203340 nonzeros
152   Variable types: 0 continuous, 10358 integer (8623 binary)
153
154   Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
155   Showing first log only...
156
157   Root relaxation presolved: 10358 rows, 75414 columns, 213698 nonzeros
158
159
160   Root simplex log...
161
162   Iteration   Objective      Primal Inf.   Dual Inf.     Time
163       0   5.3396667e+03  0.000000e+00  2.270395e+04    10s
```

```
164     3562   5.3429611e+03  0.000000e+00  3.213694e+04    10s
165     8796   5.3396667e+03  0.000000e+00  0.000000e+00    11s
166     8796   5.3396667e+03  0.000000e+00  0.000000e+00    11s
167  Concurrent spin time: 0.09s
168
169  Solved with primal simplex
170
171  Root relaxation: objective 5.339667e+03, 8796 iterations, 1.39 seconds (1.44 work units)
172
173      Nodes    |    Current Node    |     Objective Bounds     |     Work
174   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
175
176      0     0 5339.66667    0  225          - 5339.66667      -     -  13s
177      0     0 5339.66667    0  533          - 5339.66667      -     -  16s
178      0     0 5339.66667    0  493          - 5339.66667      -     -  17s
179  H   0     0                  5339.6666667 5339.66667  0.00%     -  24s
180      0     0 5339.66667    0  178 5339.66667 5339.66667  0.00%     -  25s
181
182  Cutting planes:
183    Learned: 1
184    Gomory: 11
185    Lift-and-project: 17
186    Cover: 144
187    Implied bound: 234
188    Clique: 3749
189    MIR: 99
190    StrongCG: 39
191    Flow cover: 4
192    GUB cover: 69
193    Zero half: 68
194    RLT: 39
195    Relax-and-lift: 123
196    BQP: 65
197
198  Explored 1 nodes (41774 simplex iterations) in 25.13 seconds (33.60 work units)
199  Thread count was 8 (of 8 available processors)
200
201  Solution count 1: 5339.67
202
203  Optimal solution found (tolerance 5.00e-02)
204  Best objective 5.339666666667e+03, best bound 5.339666666667e+03, gap 0.0000%
205  Set parameter MIPGap to value 1e-08
206  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
207
208  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
209  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
210
211  Optimize a model with 1153828 rows, 901813 columns and 7829795 nonzeros
212  Model fingerprint: 0x05f8cced
213  Variable types: 441325 continuous, 460488 integer (456438 binary)
214  Coefficient statistics:
215    Matrix range     [1e-01, 1e+10]
216    Objective range  [6e-05, 5e+01]
217    Bounds range     [1e+00, 8e+01]
218    RHS range        [8e-01, 1e+10]
219  Warning: Model contains large matrix coefficients
220  Warning: Model contains large rhs
221        Consider reformulating model or setting NumericFocus parameter
222        to avoid numerical issues.
223  Presolve removed 1150527 rows and 900729 columns
224  Presolve time: 2.50s
225  Presolved: 3301 rows, 1084 columns, 9052 nonzeros
226  Variable types: 0 continuous, 1084 integer (604 binary)
227
228  Root relaxation: objective 4.752667e+03, 1117 iterations, 0.02 seconds (0.02 work units)
229
230      Nodes    |    Current Node    |     Objective Bounds     |     Work
231   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
232
233  H   0     0                  4752.6666667 11412.6667   140%     -   3s
234      0     0          -    0    4752.66667 4752.66667  0.00%     -   3s
235
236  Explored 1 nodes (1360 simplex iterations) in 3.29 seconds (3.42 work units)
237  Thread count was 8 (of 8 available processors)
238
239  Solution count 1: 4752.67
240
241  Optimal solution found (tolerance 1.00e-08)
242  Best objective 4.752666666667e+03, best bound 4.752666666667e+03, gap 0.0000%
243  SP is solved
244  SP's optimal solution is'□4752
245
246   Itr = 1
247  Collect_LB =  [682.0, 5339.666666666666]
```

```
248  Collect_UB =  [9727.333333333332, 5569.666666666666]
249  Collect_Hua =  [0.0, 4522.666666666666]
250  Collect_SPObjVal =  [4522.666666666666, 4752.666666666666]
251  Collect_MPObjValNHua =  [682.0, 817.0]
252
253
254  Set parameter MIPGap to value 0.05
255  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
256
257  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
258  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
259
260  Optimize a model with 870275 rows, 163849 columns and 2633664 nonzeros
261  Model fingerprint: 0xd1a1d38d
262  Variable types: 1 continuous, 163848 integer (148668 binary)
263  Coefficient statistics:
264    Matrix range     [1e-01, 1e+10]
265    Objective range  [1e+00, 2e+01]
266    Bounds range     [1e+00, 1e+00]
267    RHS range        [1e+00, 2e+10]
268  Warning: Model contains large matrix coefficients
269  Warning: Model contains large rhs
270        Consider reformulating model or setting NumericFocus parameter
271        to avoid numerical issues.
272  Presolve removed 714204 rows and 142528 columns (presolve time = 5s) ...
273  Presolve removed 725770 rows and 143165 columns (presolve time = 10s) ...
274  Presolve removed 778334 rows and 149548 columns
275  Presolve time: 13.32s
276  Presolved: 91941 rows, 14301 columns, 308920 nonzeros
277  Variable types: 0 continuous, 14301 integer (10861 binary)
278
279  Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
280  Showing first log only...
281
282  Root relaxation presolved: 14301 rows, 106242 columns, 323221 nonzeros
283
284
285  Root simplex log...
286
287  Iteration    Objective      Primal Inf.   Dual Inf.     Time
288      0   5.5946667e+03   0.000000e+00   4.448889e+04     14s
289   8213   5.6008226e+03   0.000000e+00   6.014557e+05     15s
290  14725   5.5946667e+03   0.000000e+00   0.000000e+00     16s
291  14725   5.5946667e+03   0.000000e+00   0.000000e+00     16s
292  Concurrent spin time: 0.20s
293
294  Solved with primal simplex
295
296  Root relaxation: objective 5.594667e+03, 14725 iterations, 2.62 seconds (2.73 work units)
297  Total elapsed time = 20.28s
298
299     Nodes    |    Current Node    |     Objective Bounds      |     Work
300   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
301
302     0     0 5594.66667    0  513          -  5594.66667      -     -   22s
303     0     0 5594.66667    0  528          -  5594.66667      -     -   22s
304     0     0 5594.66667    0  530          -  5594.66667      -     -   22s
305     0     0 5594.66667    0  707          -  5594.66667      -     -   27s
306     0     0 5594.66667    0  922          -  5594.66667      -     -   30s
307     0     0 5594.66667    0  924          -  5594.66667      -     -   30s
308     0     0 5594.66667    0  372          -  5594.66667      -     -   42s
309     0     0 5594.66667    0  444          -  5594.66667      -     -   43s
310     0     0 5594.66667    0  362          -  5594.66667      -     -   50s
311     0     0 5594.66667    0  386          -  5594.66667      -     -   50s
312     0     0 5594.66667    0  512          -  5594.66667      -     -   51s
313     0     0 5594.66667    0  183          -  5594.66667      -     -   58s
314     0     0 5594.66667    0  184          -  5594.66667      -     -   59s
315     0     0 5594.66667    0  175          -  5594.66667      -     -   59s
316     0     0 5594.66667    0  301          -  5594.66667      -     -   63s
317     0     0 5594.66667    0  348          -  5594.66667      -     -   63s
318     0     0 5594.66667    0  350          -  5594.66667      -     -   63s
319     0     0 5594.66667    0  319          -  5594.66667      -     -   64s
320     0     0 5594.66667    0  179          -  5594.66667      -     -   68s
321     0     0 5594.66667    0  187          -  5594.66667      -     -   68s
322     0     0 5594.66667    0  187          -  5594.66667      -     -   70s
323     0     2 5594.66667    0  187          -  5594.66667      -     -   79s
324     1     4 5594.66667    1  193          -  5594.66667      -  7622   80s
325     7    12 5594.66667    3  269          -  5594.66667      -  3549   86s
326    11    16 5594.66667    3 1050          -  5594.66667      -  3984   94s
327    15    19 5594.66667    4  274          -  5594.66667      -  5793   97s
328    19    23 5594.66667    5  244          -  5594.66667      -  5208  101s
329    29    45 5594.66667    8  238          -  5594.66667      -  4349  110s
330    47    77 5594.66667   15  180          -  5594.66667      -  3556  120s
331   103   193 5594.66667   37  125          -  5594.66667      -  2181  132s
```

```
332    284   463 5594.66667  88  108       - 5594.66667    -  897  144s
333    618   748 6114.66667 184  396       - 5594.66667    -  462  156s
334  *  858   496          368  5594.6666667 5594.66667 0.00%  370  157s
335
336  Cutting planes:
337    Learned: 21
338    Gomory: 2
339    Cover: 554
340    Implied bound: 347
341    Clique: 6033
342    MIR: 235
343    StrongCG: 86
344    Flow cover: 17
345    GUB cover: 62
346    Zero half: 28
347    Network: 1
348    RLT: 129
349    Relax-and-lift: 565
350    BQP: 53
351    PSD: 4
352
353  Explored 964 nodes (498809 simplex iterations) in 157.12 seconds (343.88 work units)
354  Thread count was 8 (of 8 available processors)
355
356  Solution count 1: 5594.67
357
358  Optimal solution found (tolerance 5.00e-02)
359  Best objective 5.594666666667e+03, best bound 5.594666666667e+03, gap 0.0000%
360  Warning: linear constraint 365024 and linear constraint 617650 have the same name "ConSP25_1[0,0]"
361  Set parameter MIPGap to value 1e-08
362  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
363
364  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
365  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
366
367  Optimize a model with 1153828 rows, 901813 columns and 7829795 nonzeros
368  Model fingerprint: 0xf2f10219
369  Variable types: 441325 continuous, 460488 integer (456438 binary)
370  Coefficient statistics:
371    Matrix range    [1e-01, 1e+10]
372    Objective range [6e-05, 5e+01]
373    Bounds range    [1e+00, 8e+01]
374    RHS range       [8e-01, 1e+10]
375  Warning: Model contains large matrix coefficients
376  Warning: Model contains large rhs
377          Consider reformulating model or setting NumericFocus parameter
378          to avoid numerical issues.
379  Presolve removed 1151061 rows and 900846 columns
380  Presolve time: 2.39s
381  Presolved: 2767 rows, 967 columns, 7422 nonzeros
382  Variable types: 0 continuous, 967 integer (548 binary)
383  Found heuristic solution: objective 3999.6666667
384
385  Root relaxation: objective 4.762667e+03, 753 iterations, 0.01 seconds (0.01 work units)
386
387    Nodes   |   Current Node   |   Objective Bounds    |    Work
388   Expl Unexpl | Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
389
390     0    0 4762.66667   0   8 3999.66667 4762.66667 19.1%   -   3s
391  H  0    0               4762.6666667 4762.66667 0.00%   -   3s
392     0    0 4762.66667   0   8 4762.66667 4762.66667 0.00%   -   3s
393
394  Explored 1 nodes (753 simplex iterations) in 3.14 seconds (3.34 work units)
395  Thread count was 8 (of 8 available processors)
396
397  Solution count 2: 4762.67 3999.67
398
399  Optimal solution found (tolerance 1.00e-08)
400  Best objective 4.762666666667e+03, best bound 4.762666666667e+03, gap 0.0000%
401  SP is solved
402  SP's optimal solution is'□4762
403
404    Itr = 2
405  Collect_LB =  [682.0, 5339.666666666666, 5594.666666666666]
406  Collect_UB =  [9727.333333333332, 5569.666666666666, 5569.666666666666]
407  Collect_Hua =  [0.0, 4522.666666666666, 4752.666666666666]
408  Collect_SPObjVal =  [4522.666666666666, 4752.666666666666, 4762.666666666666]
409  Collect_MPObjValNHua =  [682.0, 817.0, 842.0]
410
411
412    Reach the termination conditions, stop iteration
413    Values adopted from the judgeCount's th iteration, and Itr = {2}, judgeCount = {1}
414
415  ~~~~~~~~~~judgeCount = 1, SPObj_SPF = 4752.666666666666
```

```
416  Vessel i: 0:      pi: 8-13,      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: 1-34,      betaNi: 33
     ,     bi: 33
417  Vessel i: 1:      pi: 13-19,      ai-di: 10-30,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 10-30,      taoi-deltai: 10-32,      taoPi_SP-deltaPi_SP: 10-32,
     betaNi: 22,      bi: 22
418  Vessel i: 2:      pi: 19-24,      ai-di: 11-24,      gi_SP-gpi_SP: 0.000000-0.000000,      ai_SP-di: 11-24,      taoi-deltai: 11-27,      taoPi_SP-deltaPi_SP: 11-27,
     betaNi: 16,      bi: 16
419  Vessel i: 3:      pi: 24-29,      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
420  Vessel i: 4:      pi: 17-22,      ai-di: 38-63,      gi_SP-gpi_SP: 0.200000-1.000000,      ai_SP-di: 39-63,      taoi-deltai: 41-63,      taoPi_SP-deltaPi_SP: 41-63,
     betaNi: 22,      bi: 22
421  Vessel i: 5:      pi: 12-17,      ai-di: 40-50,      gi_SP-gpi_SP: 1.000000-0.200000,      ai_SP-di: 47-50,      taoi-deltai: 46-56,      taoPi_SP-deltaPi_SP: 48-56,
     betaNi: 10,      bi: 10
422
423  round LB =   [682, 5340, 5595]
424  round UB =   [9727, 5570, 5570]
425  round Hua =   [0, 4523, 4753]
426  round SPObjVal =   [4523, 4753, 4763]
427  round MPObjValNHua =   [682, 817, 842]
428
429  Time: 434.000000
430
431
432
433
```