```
"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=39380

import sys; print('Python %s on %s' % (sys.version, sys.platform))
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'])

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
>>> runfile('E:/1 □□□□/3 □□□□□/1 □□□□□□/1 □□□□□□□□/1_□□□□□□_□□□□/1_LW _□□□□/4 □□□□/3 python_code/9 Code for this paper/main_RO_TWS.py', wdir='E:/1 □□□□/3 □□□□□/1 □□□□□□/1 □□□□□□□□/1_□□□□□□_□□□□/1_LW _□□□□/4 □□□□/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
Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)

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

Optimize a model with 546361 rows, 52642 columns and 1529305 nonzeros
Model fingerprint: 0x080f55c9
Variable types: 1 continuous, 52641 integer (52605 binary)
Coefficient statistics:
  Matrix range     [1e+00, 1e+10]
  Objective range  [1e+00, 2e+01]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 2e+10]
Warning: Model contains large matrix coefficients
Warning: Model contains large rhs
         Consider reformulating model or setting NumericFocus parameter
         to avoid numerical issues.
Presolve removed 323914 rows and 24616 columns (presolve time = 5s) ...
Presolve removed 462566 rows and 35488 columns
Presolve time: 8.42s
Presolved: 83795 rows, 17154 columns, 258615 nonzeros
Variable types: 0 continuous, 17154 integer (17127 binary)

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

Root relaxation presolved: 17154 rows, 100949 columns, 275769 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    7.8000000e+02   0.000000e+00   1.001000e+03      9s
Concurrent spin time: 0.00s

Solved with dual simplex (primal model)

Root relaxation: objective 7.800000e+02, 2393 iterations, 0.38 seconds (0.38 work units)

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

     0     0  780.00000    0   14          -  780.00000      -     -    9s
     0     0  780.00000    0   38          -  780.00000      -     -   10s
H    0     0                1740.0000000  780.00000  55.2%     -   10s
     0     0  780.00000    0    6 1740.00000  780.00000  55.2%     -   11s
     0     0  780.00000    0   36 1740.00000  780.00000  55.2%     -   12s
     0     0  780.00000    0   33 1740.00000  780.00000  55.2%     -   13s
     0     0  780.00000    0   51 1740.00000  780.00000  55.2%     -   13s
     0     0  780.00000    0   88 1740.00000  780.00000  55.2%     -   14s
     0     0  780.00000    0   86 1740.00000  780.00000  55.2%     -   14s
H    0     0                780.0000000  780.00000  0.00%     -   14s
     0     0  780.00000    0    2  780.00000  780.00000  0.00%     -   14s

Cutting planes:
  Cover: 113
  Implied bound: 1178
  Clique: 21
  MIR: 117
  StrongCG: 84
  GUB cover: 6
  Zero half: 7
  Mod-K: 15
  RLT: 18
  Relax-and-lift: 16
  BQP: 3

```

```
Explored 1 nodes (24632 simplex iterations) in 14.87 seconds (27.90 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 780 1740

Optimal solution found (tolerance 1.00e-10)
Best objective 7.800000000000e+02, best bound 7.800000000000e+02, gap 0.0000%
Set parameter MIPGap to value 1e-08
Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)

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

Optimize a model with 536218 rows, 14427 columns and 1098581 nonzeros
Model fingerprint: 0x2745f528
Variable types: 36 continuous, 14391 integer (8316 binary)
Coefficient statistics:
  Matrix range     [1e-01, 1e+10]
  Objective range  [6e-05, 5e+01]
  Bounds range     [1e+00, 1e+00]
  RHS range        [8e-01, 1e+10]
Warning: Model contains large matrix coefficients
Warning: Model contains large rhs
         Consider reformulating model or setting NumericFocus parameter
         to avoid numerical issues.
Presolve removed 533187 rows and 13299 columns
Presolve time: 0.35s
Presolved: 3031 rows, 1128 columns, 8112 nonzeros
Variable types: 6 continuous, 1122 integer (664 binary)
Found heuristic solution: objective 3035.0500186
Found heuristic solution: objective 3411.0500186

Root relaxation: objective 4.891050e+03, 877 iterations, 0.00 seconds (0.01 work units)

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

*    0     0               0    4891.0500186 4891.05002  0.00%     -    0s

Explored 1 nodes (1171 simplex iterations) in 0.49 seconds (0.73 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 4891.05 3411.05 3035.05

Optimal solution found (tolerance 1.00e-08)
Best objective 4.891050018628e+03, best bound 4.891050018628e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□4891

 Itr = 0
Collect_LB =   [780.0]
Collect_UB =   [10562.10003725563]
Collect_Hua =   [0.0]
Collect_SPObjVal =   [4891.050018627815]
Collect_MPObjValNHua =   [780.0]


Set parameter MIPGap to value 1e-10
Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)

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

Optimize a model with 554090 rows, 283978 columns and 1537070 nonzeros
Model fingerprint: 0x1f2ee4d5
Variable types: 1 continuous, 283977 integer (283941 binary)
Coefficient statistics:
  Matrix range     [1e+00, 1e+10]
  Objective range  [1e+00, 2e+01]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 2e+10]
Warning: Model contains large matrix coefficients
Warning: Model contains large rhs
         Consider reformulating model or setting NumericFocus parameter
         to avoid numerical issues.
Presolve removed 395543 rows and 265240 columns (presolve time = 5s) ...
Presolve removed 502228 rows and 275364 columns
Presolve time: 9.04s
Presolved: 51862 rows, 8614 columns, 134659 nonzeros
Variable types: 0 continuous, 8614 integer (8587 binary)
Root relaxation presolved: 8614 rows, 60476 columns, 143273 nonzeros


Root simplex log...
```

```
164
165  Iteration    Objective       Primal Inf.    Dual Inf.      Time
166         0     handle free variables                         9s
167      5701    5.7390404e+03   2.617869e+04   0.000000e+00     10s
168      6798    5.6710500e+03   0.000000e+00   0.000000e+00     10s
169      6798    5.6710500e+03   0.000000e+00   0.000000e+00     10s
170
171  Root relaxation: objective 5.671050e+03, 6798 iterations, 0.94 seconds (1.80 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 5671.05002    0   57          - 5671.05002      -     -   10s
177      0     0 5671.05002    0  204          - 5671.05002      -     -   12s
178      0     0 5671.05002    0  262          - 5671.05002      -     -   13s
179      0     0 5671.05002    0  190          - 5671.05002      -     -   13s
180      0     0 5671.05002    0  175          - 5671.05002      -     -   13s
181      0     0 5671.05002    0   29          - 5671.05002      -     -   15s
182      0     0 5671.05002    0   33          - 5671.05002      -     -   15s
183      0     0 5671.05002    0   26          - 5671.05002      -     -   16s
184      0     0 5671.05002    0   89          - 5671.05002      -     -   16s
185      0     0 5671.05002    0   89          - 5671.05002      -     -   16s
186      0     0 5671.05002    0   35          - 5671.05002      -     -   17s
187      0     0 5671.05002    0   93          - 5671.05002      -     -   17s
188      0     0 5671.05002    0  201          - 5671.05002      -     -   18s
189      0     0 5671.05002    0  196          - 5671.05002      -     -   18s
190      0     0 5671.05002    0    1          - 5671.05002      -     -   20s
191  H   0     0                6031.0500186 5671.05002  5.97%     -   20s
192  H   0     0                5931.0500186 5671.05002  4.38%     -   20s
193      0     0 5671.05002    0   71 5931.05002 5671.05002  4.38%     -   20s
194      0     0 5671.05002    0   87 5931.05002 5671.05002  4.38%     -   20s
195      0     0 5671.05002    0   75 5931.05002 5671.05002  4.38%     -   20s
196      0     0 5671.05002    0   33 5931.05002 5671.05002  4.38%     -   23s
197      0     0 5671.05002    0   31 5931.05002 5671.05002  4.38%     -   23s
198      0     0 5671.05002    0   22 5931.05002 5671.05002  4.38%     -   23s
199  H   0     0                5671.0500186 5671.05002  0.00%     -   24s
200      0     0 5671.05002    0   22 5671.05002 5671.05002  0.00%     -   24s
201
202  Cutting planes:
203    Learned: 2
204    Gomory: 6
205    Cover: 256
206    Implied bound: 1717
207    Clique: 2678
208    MIR: 38
209    StrongCG: 18
210    GUB cover: 16
211    Zero half: 2
212    RLT: 19
213    Relax-and-lift: 68
214    BQP: 6
215
216  Explored 1 nodes (63444 simplex iterations) in 24.09 seconds (36.30 work units)
217  Thread count was 8 (of 8 available processors)
218
219  Solution count 3: 5671.05 5931.05 6031.05
220
221  Optimal solution found (tolerance 1.00e-10)
222  Best objective 5.671050018628e+03, best bound 5.671050018628e+03, gap 0.0000%
223  Set parameter MIPGap to value 1e-08
224  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
225
226  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
227  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
228
229  Optimize a model with 536218 rows, 14427 columns and 1098581 nonzeros
230  Model fingerprint: 0x284c0df0
231  Variable types: 36 continuous, 14391 integer (8316 binary)
232  Coefficient statistics:
233    Matrix range     [1e-01, 1e+10]
234    Objective range  [6e-05, 5e+01]
235    Bounds range     [1e+00, 1e+00]
236    RHS range        [8e-01, 1e+10]
237  Warning: Model contains large matrix coefficients
238  Warning: Model contains large rhs
239           Consider reformulating model or setting NumericFocus parameter
240           to avoid numerical issues.
241  Presolve removed 531497 rows and 12811 columns
242  Presolve time: 0.37s
243  Presolved: 4721 rows, 1616 columns, 12482 nonzeros
244  Variable types: 8 continuous, 1608 integer (932 binary)
245  Found heuristic solution: objective 3527.0500186
246
247  Root relaxation: objective 5.350670e+03, 1452 iterations, 0.02 seconds (0.01 work units)
```

```
248
249     Nodes    |    Current Node    |     Objective Bounds      |     Work
250  Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
251
252 *    0     0               0    5350.6702574 5350.67026  0.00%     -    0s
253
254 Explored 1 nodes (1988 simplex iterations) in 0.51 seconds (0.76 work units)
255 Thread count was 8 (of 8 available processors)
256
257 Solution count 2: 5350.67 3527.05
258
259 Optimal solution found (tolerance 1.00e-08)
260 Best objective 5.350670257367e+03, best bound 5.350670257367e+03, gap 0.0000%
261 SP is solved
262 SP's optimal solution is'□5350
263
264  Itr = 1
265 Collect_LB =   [780.0, 5671.050018627815]
266 Collect_UB =   [10562.10003725563, 6130.670257367259]
267 Collect_Hua =   [0.0, 4891.050018627815]
268 Collect_SPObjVal =   [4891.050018627815, 5350.670257367259]
269 Collect_MPObjValNHua =   [780.0, 780.0]
270
271
272 Set parameter MIPGap to value 1e-10
273 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
274
275 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
276 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
277
278 Optimize a model with 554090 rows, 283978 columns and 1537070 nonzeros
279 Model fingerprint: 0xc483bd64
280 Variable types: 1 continuous, 283977 integer (283941 binary)
281 Coefficient statistics:
282   Matrix range     [1e+00, 1e+10]
283   Objective range  [1e+00, 2e+01]
284   Bounds range     [1e+00, 1e+00]
285   RHS range        [1e+00, 2e+10]
286 Warning: Model contains large matrix coefficients
287 Warning: Model contains large rhs
288         Consider reformulating model or setting NumericFocus parameter
289         to avoid numerical issues.
290 Presolve removed 396525 rows and 265461 columns (presolve time = 5s) ...
291 Presolve removed 502087 rows and 275434 columns
292 Presolve time: 8.73s
293 Presolved: 52003 rows, 8544 columns, 133454 nonzeros
294 Variable types: 0 continuous, 8544 integer (8517 binary)
295 Root relaxation presolved: 8544 rows, 60547 columns, 141998 nonzeros
296
297
298 Root simplex log...
299
300 Iteration    Objective       Primal Inf.    Dual Inf.      Time
301        0      handle free variables                      9s
302     6460    6.1306703e+03   0.000000e+00   0.000000e+00     10s
303     6460    6.1306703e+03   0.000000e+00   0.000000e+00     10s
304
305 Root relaxation: objective 6.130670e+03, 6460 iterations, 0.84 seconds (1.48 work units)
306 Total elapsed time = 10.09s
307
308     Nodes    |    Current Node    |     Objective Bounds      |     Work
309  Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
310
311      0     0 6130.67026    0   12          - 6130.67026      -     -   10s
312      0     0 6130.67026    0   61          - 6130.67026      -     -   11s
313      0     0 6130.67026    0   57          - 6130.67026      -     -   11s
314      0     0 6130.67026    0    3         - 6130.67026      -     -   13s
315      0     0 6130.67026    0    5         - 6130.67026      -     -   13s
316      0     0 6130.67026    0   15          - 6130.67026      -     -   13s
317      0     0 6130.67026    0   13          - 6130.67026      -     -   13s
318      0     0 6130.67026    0   54          - 6130.67026      -     -   14s
319      0     0 6130.67026    0   53          - 6130.67026      -     -   14s
320 H    0     0                6130.6702574 6130.67026  0.00%     -   15s
321      0     0 6130.67026    0   10 6130.67026 6130.67026  0.00%     -   15s
322
323 Cutting planes:
324   Gomory: 4
325   Cover: 181
326   Implied bound: 1274
327   Clique: 747
328   MIR: 48
329   StrongCG: 36
330   GUB cover: 10
331   Zero half: 5
```

```
  RLT: 9
  Relax-and-lift: 26
  BQP: 1

Explored 1 nodes (25838 simplex iterations) in 15.27 seconds (23.68 work units)
Thread count was 8 (of 8 available processors)

Solution count 1: 6130.67

Optimal solution found (tolerance 1.00e-10)
Best objective 6.130670257367e+03, best bound 6.130670257367e+03, gap 0.0000%
Set parameter MIPGap to value 1e-08
Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)

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

Optimize a model with 536218 rows, 14427 columns and 1098581 nonzeros
Model fingerprint: 0x7dcc548d
Variable types: 36 continuous, 14391 integer (8316 binary)
Coefficient statistics:
  Matrix range     [1e-01, 1e+10]
  Objective range  [6e-05, 5e+01]
  Bounds range     [1e+00, 1e+00]
  RHS range        [8e-01, 1e+10]
Warning: Model contains large matrix coefficients
Warning: Model contains large rhs
         Consider reformulating model or setting NumericFocus parameter
         to avoid numerical issues.
Presolve removed 531456 rows and 12796 columns
Presolve time: 0.37s
Presolved: 4762 rows, 1631 columns, 12671 nonzeros
Variable types: 8 continuous, 1623 integer (939 binary)
Found heuristic solution: objective 3541.6702574
Found heuristic solution: objective 3586.6702574

Root relaxation: objective 5.389451e+03, 1373 iterations, 0.01 seconds (0.01 work units)

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

     0     0 5389.45145    0   10 3586.67026 5389.45145  50.3%     -    0s
H    0     0                    4154.4514539 5389.45145  29.7%     -    0s
H    0     0                    5389.4514539 5389.45145  0.00%     -    0s
     0     0 5389.45145    0   10 5389.45145 5389.45145  0.00%     -    0s

Explored 1 nodes (1923 simplex iterations) in 0.52 seconds (0.79 work units)
Thread count was 8 (of 8 available processors)

Solution count 4: 5389.45 4154.45 3586.67 3541.67

Optimal solution found (tolerance 1.00e-08)
Best objective 5.389451453897e+03, best bound 5.389451453897e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□5389

 Itr = 2
Collect_LB =   [780.0, 5671.050018627815, 6130.670257367259]
Collect_UB =   [10562.10003725563, 6130.670257367259, 6130.670257367259]
Collect_Hua =   [0.0, 4891.050018627815, 5350.670257367259]
Collect_SPObjVal =   [4891.050018627815, 5350.670257367259, 5389.451453896589]
Collect_MPObjValNHua =   [780.0, 780.0, 780.0]


  Reach the termination conditions, stop iteration
  Values adopted from the Itr-1' th iteration, and Itr = {2}, judgeCount = {1}

~~~~~~~~~~judgeCount = 1, SPObj_SPF = 5350.670257367259
Vessel i: 0:     pi: 0-5,     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: 1:     pi: 5-11,     ai-di: 7-21,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 7-21,     taoi-deltai: 7-17,     taoPi_SP-deltaPi_SP: 7-17,     betaNi: 10,     bi: 10
Vessel i: 2:     pi: 5-10,     ai-di: 19-34,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 19-34,     taoi-deltai: 19-30,     taoPi_SP-deltaPi_SP: 19-30,     betaNi: 11,     bi: 11
Vessel i: 3:     pi: 3-9,     ai-di: 31-42,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 31-42,     taoi-deltai: 31-38,     taoPi_SP-deltaPi_SP: 31-38,     betaNi: 7,     bi: 7
Vessel i: 4:     pi: 3-10,     ai-di: 39-78,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 39-78,     taoi-deltai: 39-73,     taoPi_SP-deltaPi_SP: 39-73,     betaNi: 34,     bi: 34
Vessel i: 5:     pi: 18-24,     ai-di: 14-42,     gi_SP-gpi_SP: 0.000000-0.800000,     ai_SP-di: 14-42,     taoi-deltai: 18-28,     taoPi_SP-deltaPi_SP: 18-28,     betaNi: 10,     bi: 10
Vessel i: 6:     pi: 10-17,     ai-di: 17-74,     gi_SP-gpi_SP: 1.000000-0.000000,     ai_SP-di: 25-74,     taoi-deltai: 25-55,     taoPi_SP-deltaPi_SP: 25-55,     betaNi: 30,     bi: 30
Vessel i: 7:     pi: 18-23,     ai-di: 35-62,     gi_SP-gpi_SP: 0.400000-1.000000,     ai_SP-di: 39-62,     taoi-deltai: 35-42,     taoPi_SP-deltaPi_SP: 39-42,     betaNi: 7,     bi: 7
```

```
Vessel i: 8:     pi: 29-34,     ai-di: 51-79,     gi_SP-gpi_SP: 1.000000-0.600000,     ai_SP-di: 58-79,     taoi-deltai: 55-62,     taoPi_SP-deltaPi_SP: 58-62,
    betaNi: 7,     bi: 7

round LB =   [780, 5671, 6131]
round UB =   [10562, 6131, 6131]
round Hua =   [0, 4891, 5351]
round SPObjVal =   [4891, 5351, 5389]
round MPObjValNHua =   [780, 780, 780]

OptimalObj = 6130.670257367259
Time: 121.000000
```