```
"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=12683

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_BDC.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 364631 rows, 34789 columns and 1009585 nonzeros
Model fingerprint: 0x41ef63bd
Variable types: 1 continuous, 34788 integer (34764 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 190091 rows and 13685 columns (presolve time = 5s) ...
Presolve removed 314899 rows and 22411 columns
Presolve time: 6.02s
Presolved: 49732 rows, 12378 columns, 187547 nonzeros
Variable types: 0 continuous, 12378 integer (12360 binary)

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

Root relaxation presolved: 49728 rows, 12382 columns, 187535 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    6.2000000e+02   6.000000e+01   1.249056e+08      6s
Concurrent spin time: 0.02s

Solved with dual simplex (primal model)

Root relaxation: objective 6.200000e+02, 1412 iterations, 0.22 seconds (0.21 work units)

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

     0     0  620.00000    0    8          -  620.00000      -     -    6s
H    0     0                     900.0000000  620.00000  31.1%     -    6s
     0     0  620.00000    0   26  900.00000  620.00000  31.1%     -    7s
H    0     0                     620.0000000  620.00000  0.00%     -    7s
     0     0  620.00000    0   26  620.00000  620.00000  0.00%     -    7s

Cutting planes:
  Gomory: 1
  Cover: 2
  Clique: 1
  MIR: 4
  StrongCG: 3
  GUB cover: 3

Explored 1 nodes (5160 simplex iterations) in 7.66 seconds (12.22 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 620 900

Optimal solution found (tolerance 1.00e-10)
Best objective 6.200000000000e+02, best bound 6.200000000000e+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 1153892 rows, 901813 columns and 7829944 nonzeros
Model fingerprint: 0x8d9ba9f4
Variable types: 441325 continuous, 460488 integer (456438 binary)
Coefficient statistics:
  Matrix range     [1e-01, 1e+10]
  Objective range  [6e-05, 5e+01]
  Bounds range     [1e+00, 8e+01]
  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 1152919 rows and 901394 columns
Presolve time: 2.63s
Presolved: 973 rows, 419 columns, 2651 nonzeros
Variable types: 4 continuous, 415 integer (248 binary)
Found heuristic solution: objective 2999.9099577
Found heuristic solution: objective 3517.6666667

Root relaxation: objective 3.998167e+03, 288 iterations, 0.00 seconds (0.00 work units)

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

*    0     0               0    3998.1666667 3998.16667  0.00%     -    3s

Explored 1 nodes (438 simplex iterations) in 3.38 seconds (3.51 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 3998.17 3517.67 2999.91

Optimal solution found (tolerance 1.00e-08)
Best objective 3.998166666667e+03, best bound 3.998166666667e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□3998

  Itr = 0
Collect_LB =   [620.0]
Collect_UB =   [8616.333333333328]
Collect_Hua =   [0.0]
Collect_SPObjVal =   [3998.1666666666642]
Collect_MPObjValNHua =   [620.0]


Set parameter TimeLimit to value 12000
Set parameter MIPGap to value 0.0005
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 369957 rows, 137605 columns and 1014938 nonzeros
Model fingerprint: 0x117b1f13
Variable types: 1 continuous, 137604 integer (137580 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 236567 rows and 122590 columns (presolve time = 5s) ...
Presolve removed 329768 rows and 131235 columns
Presolve time: 5.84s
Presolved: 40189 rows, 6370 columns, 102107 nonzeros
Variable types: 0 continuous, 6370 integer (6352 binary)
Root relaxation presolved: 6370 rows, 46559 columns, 108477 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0      handle free variables                      6s
    5474    4.6256667e+03   0.000000e+00   0.000000e+00      7s
    5474    4.6256667e+03   0.000000e+00   0.000000e+00      7s

Root relaxation: objective 4.625667e+03, 5474 iterations, 0.72 seconds (1.35 work units)

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

```
164
165       0     0 4625.66667    0   14          - 4625.66667      -     -    7s
166       0     0 4625.66667    0   58          - 4625.66667      -     -    8s
167       0     0 4625.66667    0   54          - 4625.66667      -     -    8s
168       0     0 4625.66667    0   61          - 4625.66667      -     -    8s
169       0     0 4625.66667    0   58          - 4625.66667      -     -    8s
170       0     0 4625.66667    0   48          - 4625.66667      -     -    9s
171       0     0 4625.66667    0   56          - 4625.66667      -     -    9s
172       0     0 4625.66667    0   57          - 4625.66667      -     -   10s
173  H    0     0                 7525.6666667 4625.66667  38.5%     -   10s
174       0     0 4625.66667    0   55 7525.66667 4625.66667  38.5%     -   10s
175  H    0     0                 5845.6666667 4625.66667  20.9%     -   11s
176       0     2 4625.66667    0   55 5845.66667 4625.66667  20.9%     -   13s
177       9     5 4625.66667    4  188 5845.66667 4625.66667  20.9%  1133   15s
178  H   30    18                 5825.6666667 4625.66667  20.6%  1073   16s
179      66    51 4625.66667   15  450 5825.66667 4625.66667  20.6%  1037   20s
180  H  107    74                 5785.6666667 4625.66667  20.0%   886   23s
181  H  154   118                 5385.6666667 4625.66667  14.1%   763   24s
182     193   145 4625.66667   22  479 5385.66667 4625.66667  14.1%   668   26s
183  H  239   145                 5025.6666667 4625.66667  7.96%   543   26s
184     305   222 4625.66667   28  400 5025.66667 4625.66667  7.96%   543   30s
185  H  325   222                 4985.6666667 4625.66667  7.22%   540   30s
186  H  388   299                 4725.6666667 4625.66667  2.12%   470   32s
187     498   275 4625.66667   40  219 4725.66667 4625.66667  2.12%   403   35s
188     819   348 4625.66667   58  291 4725.66667 4625.66667  2.12%   323   41s
189    1125   348 4625.66667   70  285 4725.66667 4625.66667  2.12%   283   45s
190  H 1140   282                 4665.6666667 4625.66667  0.86%   286   45s
191    1628   173 infeasible   69      4665.66667 4625.66667  0.86%   284   52s
192    1830   119 infeasible   51      4665.66667 4625.66667  0.86%   275   55s
193    2371    46 4625.66667   24  412 4665.66667 4625.66667  0.86%   250   60s
194
195  Cutting planes:
196    Learned: 9
197    Gomory: 3
198    Cover: 889
199    Implied bound: 426
200    Clique: 1280
201    MIR: 202
202    StrongCG: 168
203    GUB cover: 7
204    Inf proof: 10
205    Zero half: 4
206    RLT: 7
207    Relax-and-lift: 460
208    BQP: 18
209
210  Explored 2541 nodes (666946 simplex iterations) in 60.89 seconds (114.03 work units)
211  Thread count was 8 (of 8 available processors)
212
213  Solution count 9: 4665.67 4725.67 4985.67 ... 7525.67
214
215  Optimal solution found (tolerance 5.00e-04)
216  Best objective 4.665666666667e+03, best bound 4.665666666667e+03, gap 0.0000%
217  Set parameter MIPGap to value 1e-08
218  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
219
220  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
221  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
222
223  Optimize a model with 1153892 rows, 901813 columns and 7829944 nonzeros
224  Model fingerprint: 0xff36a28a
225  Variable types: 441325 continuous, 460488 integer (456438 binary)
226  Coefficient statistics:
227    Matrix range     [1e-01, 1e+10]
228    Objective range  [6e-05, 5e+01]
229    Bounds range     [1e+00, 8e+01]
230    RHS range        [8e-01, 1e+10]
231  Warning: Model contains large matrix coefficients
232  Warning: Model contains large rhs
233           Consider reformulating model or setting NumericFocus parameter
234           to avoid numerical issues.
235  Presolve removed 1149765 rows and 900440 columns
236  Presolve time: 4.92s
237  Presolved: 4127 rows, 1373 columns, 10970 nonzeros
238  Variable types: 4 continuous, 1369 integer (790 binary)
239  Found heuristic solution: objective 2815.0330732
240
241  Root simplex log...
242
243  Iteration    Objective       Primal Inf.    Dual Inf.      Time
244         0    8.4970000e+03   4.544912e+03   0.000000e+00      6s
245      1149    4.3006667e+03   0.000000e+00   0.000000e+00      6s
246
247  Root relaxation: objective 4.300667e+03, 1149 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  H    0     0                    4300.6666667 12185.0000   183%     -    5s
253       0     0        -    0      4300.66667 4300.66667  0.00%     -    5s
254
255  Explored 1 nodes (1474 simplex iterations) in 5.93 seconds (3.18 work units)
256  Thread count was 8 (of 8 available processors)
257
258  Solution count 2: 4300.67 2815.03
259
260  Optimal solution found (tolerance 1.00e-08)
261  Best objective 4.300666666667e+03, best bound 4.300666666667e+03, gap 0.0000%
262  SP is solved
263  SP's optimal solution is'□4300
264
265   Itr = 1
266  Collect_LB =   [620.0, 4665.666666666664]
267  Collect_UB =   [8616.333333333328, 4968.166666666664]
268  Collect_Hua =   [0.0, 3998.1666666666642]
269  Collect_SPObjVal =   [3998.1666666666642, 4300.666666666664]
270  Collect_MPObjValNHua =   [620.0, 667.5]
271
272
273  Set parameter TimeLimit to value 12000
274  Set parameter MIPGap to value 0.0005
275  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
276
277  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
278  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
279
280  Optimize a model with 369958 rows, 137605 columns and 1014951 nonzeros
281  Model fingerprint: 0x5e9a1cf6
282  Variable types: 1 continuous, 137604 integer (137580 binary)
283  Coefficient statistics:
284    Matrix range     [1e+00, 1e+10]
285    Objective range  [1e+00, 2e+01]
286    Bounds range     [1e+00, 1e+00]
287    RHS range        [1e+00, 2e+10]
288  Warning: Model contains large matrix coefficients
289  Warning: Model contains large rhs
290           Consider reformulating model or setting NumericFocus parameter
291           to avoid numerical issues.
292  Presolve removed 235687 rows and 122445 columns (presolve time = 5s) ...
293  Presolve removed 347333 rows and 131237 columns
294  Presolve time: 6.09s
295  Presolved: 22625 rows, 6368 columns, 84493 nonzeros
296  Variable types: 0 continuous, 6368 integer (6349 binary)
297
298  Root simplex log...
299
300  Iteration    Objective       Primal Inf.    Dual Inf.      Time
301         0    2.3206667e+03   9.296250e+02   0.000000e+00      6s
302      2285    4.9606667e+03   0.000000e+00   0.000000e+00      6s
303
304  Root relaxation: objective 4.960667e+03, 2285 iterations, 0.13 seconds (0.28 work units)
305
306      Nodes    |    Current Node    |    Objective Bounds      |     Work
307   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
308
309       0     0 4960.66667    0   21          - 4960.66667      -     -    6s
310       0     0 4960.66667    0  307          - 4960.66667      -     -    7s
311       0     0 4960.66667    0  288          - 4960.66667      -     -    7s
312       0     0 4960.66667    0  272          - 4960.66667      -     -    7s
313       0     0 4960.66667    0  166          - 4960.66667      -     -    7s
314       0     0 4960.66667    0  160          - 4960.66667      -     -    7s
315       0     0 4960.66667    0   46          - 4960.66667      -     -    8s
316       0     0 4960.66667    0  650          - 4960.66667      -     -    9s
317       0     0 4960.66667    0  628          - 4960.66667      -     -    9s
318       0     0 4960.66667    0   45          - 4960.66667      -     -   10s
319  H    0     0                    8600.6666667 4960.66667  42.3%     -   10s
320       0     0 4960.66667    0   45 8600.66667 4960.66667  42.3%     -   11s
321  H    0     0                    7460.6666667 4960.66667  33.5%     -   11s
322  H    0     0                    6900.6666667 4960.66667  28.1%     -   12s
323  H    0     2                    6480.6666667 4960.66667  23.5%     -   12s
324       0     2 4960.66667    0   45 6480.66667 4960.66667  23.5%     -   12s
325  H   28    22                    6140.6666667 4960.66667  19.2%   547   14s
326      39    25     cutoff   10      6140.66667 4960.66667  19.2%   411   15s
327     149   182 4960.66667   26   61 6140.66667 4960.66667  19.2%   393   20s
328  H  291   275                    5660.6666667 4960.66667  12.4%   321   23s
329  H  300   270                    5460.6666667 4960.66667  9.16%   321   23s
330     362   471 4960.66667   81   70 5460.66667 4960.66667  9.16%   305   25s
331  H  366   418                    5080.6666667 4960.66667  2.36%   302   25s
```

```
 H  598   405                 4980.6666667 4960.66667  0.40%   239   27s
   867   345 4960.66667   24  240 4980.66667 4960.66667  0.40%   189   30s
 H  882   345                 4960.6666667 4960.66667  0.00%   190   30s

Cutting planes:
  Learned: 327
  Gomory: 3
  Cover: 728
  Implied bound: 1932
  Clique: 98
  MIR: 311
  StrongCG: 98
  GUB cover: 9
  Zero half: 14
  RLT: 3
  Relax-and-lift: 220
  BQP: 4

Explored 1171 nodes (214747 simplex iterations) in 30.11 seconds (49.90 work units)
Thread count was 8 (of 8 available processors)

Solution count 10: 4960.67 4980.67 5080.67 ... 8600.67

Optimal solution found (tolerance 5.00e-04)
Best objective 4.960666666667e+03, best bound 4.960666666667e+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 1153892 rows, 901813 columns and 7829944 nonzeros
Model fingerprint: 0xe75659ae
Variable types: 441325 continuous, 460488 integer (456438 binary)
Coefficient statistics:
  Matrix range     [1e-01, 1e+10]
  Objective range  [6e-05, 5e+01]
  Bounds range     [1e+00, 8e+01]
  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 1150125 rows and 900516 columns
Presolve time: 2.70s
Presolved: 3767 rows, 1297 columns, 10022 nonzeros
Variable types: 4 continuous, 1293 integer (749 binary)
Found heuristic solution: objective 2885.6666667

Root relaxation: objective 4.265667e+03, 1016 iterations, 0.02 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    4265.6666667 4265.66667  0.00%     -    3s

Explored 1 nodes (1463 simplex iterations) in 3.59 seconds (3.32 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 4265.67 2885.67

Optimal solution found (tolerance 1.00e-08)
Best objective 4.265666666667e+03, best bound 4.265666666667e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□4265

 Itr = 2
Collect_LB =   [620.0, 4665.666666666664, 4960.666666666666]
Collect_UB =   [8616.333333333328, 4968.166666666664, 4925.666666666664]
Collect_Hua =   [0.0, 3998.1666666666642, 4300.666666666666]
Collect_SPObjVal =   [3998.1666666666642, 4300.666666666664, 4265.666666666664]
Collect_MPObjValNHua =   [620.0, 667.5, 660.0]


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

~~~~~~~~~~judgeCount = 1, SPObj_SPF = 4300.666666666664
Vessel i: 0:     pi: 0-5,     ai-di: 8-25,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 8-25,     taoi-deltai: 8-23,     taoPi_SP-deltaPi_SP: 9-21,     betaNi: 15,     bi: 15
Vessel i: 1:     pi: 5-11,     ai-di: 20-40,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 20-40,     taoi-deltai: 20-38,     taoPi_SP-deltaPi_SP: 20-38,     betaNi: 18,     bi: 18
Vessel i: 2:     pi: 11-16,     ai-di: 22-41,     gi_SP-gpi_SP: 0.000000-0.000000,     ai_SP-di: 22-41,     taoi-deltai: 22-38,     taoPi_SP-deltaPi_SP: 22-38,     betaNi: 16,     bi: 16
```

```
Vessel i: 3:  pi: 16-23,  ai-di: 29-57,  gi_SP-gpi_SP: 0.000000-0.000000,  ai_SP-di: 29-57,  taoi-deltai: 29-51,  taoPi_SP-deltaPi_SP: 29-51,  betaNi: 22,  bi: 22
Vessel i: 4:  pi: 8-14,  ai-di: 35-68,  gi_SP-gpi_SP: 0.200000-1.000000,  ai_SP-di: 36-68,  taoi-deltai: 39-60,  taoPi_SP-deltaPi_SP: 39-60,  betaNi: 21,  bi: 21
Vessel i: 5:  pi: 27-34,  ai-di: 42-68,  gi_SP-gpi_SP: 1.000000-0.200000,  ai_SP-di: 49-68,  taoi-deltai: 49-60,  taoPi_SP-deltaPi_SP: 50-60,  betaNi: 11,  bi: 11

round LB =  [620, 4666, 4961]
round UB =  [8616, 4968, 4926]
round Hua =  [0, 3998, 4301]
round SPObjVal =  [3998, 4301, 4266]
round MPObjValNHua =  [620, 668, 660]

OptimalObj = 4960.666666666666
Time: 336.000000
```