```
"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=27097

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_CCG.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 377728 rows, 34789 columns and 1041116 nonzeros
Model fingerprint: 0x46f72647
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 213113 rows and 13994 columns (presolve time = 5s) ...
Presolve removed 337449 rows and 22786 columns
Presolve time: 5.97s
Presolved: 40279 rows, 12003 columns, 163014 nonzeros
Variable types: 0 continuous, 12003 integer (11988 binary)

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

Root relaxation presolved: 40277 rows, 12003 columns, 163010 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    1.0480000e+03   6.525000e+01   1.369523e+08      6s
Concurrent spin time: 0.02s

Solved with dual simplex (primal model)

Root relaxation: objective 7.880000e+02, 1547 iterations, 0.20 seconds (0.18 work units)

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

     0     0  788.00000    0   17          -  788.00000      -     -    6s
H    0     0                1768.0000000  788.00000  55.4%     -    6s
H    0     0                 788.0000000  788.00000  0.00%     -    7s
     0     0  788.00000    0  112  788.00000  788.00000  0.00%     -    7s

Cutting planes:
  Gomory: 7
  Cover: 36
  Implied bound: 6
  Clique: 2
  MIR: 32
  StrongCG: 20
  GUB cover: 1
  Zero half: 1
  RLT: 12
  Relax-and-lift: 6

Explored 1 nodes (4325 simplex iterations) in 7.23 seconds (12.17 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 788 1768

Optimal solution found (tolerance 1.00e-10)
Best objective 7.880000000000e+02, best bound 7.880000000000e+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 1153782 rows, 901813 columns and 7829634 nonzeros
Model fingerprint: 0xa106148e
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 1151511 rows and 900922 columns
Presolve time: 2.68s
Presolved: 2271 rows, 891 columns, 6113 nonzeros
Variable types: 4 continuous, 887 integer (498 binary)
Found heuristic solution: objective 3790.3983806
Found heuristic solution: objective 3850.3983806

Root relaxation: objective 5.221000e+03, 575 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

H    0     0                    5221.0000000 10131.0000  94.0%     -    3s
     0     0        -    0      5221.00000 5221.00000  0.00%     -    3s

Explored 1 nodes (836 simplex iterations) in 3.41 seconds (3.69 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 5221 3850.4 3790.4

Optimal solution found (tolerance 1.00e-08)
Best objective 5.221000000000e+03, best bound 5.221000000000e+03, gap 0.0000%
SP is solved
SP's optimal solution is'□5221

  Itr = 0
Collect_LB =   [788.0]
Collect_UB =   [11230.000000000004]
Collect_Hua =   [0.0]
Collect_SPObjVal =   [5221.000000000002]
Collect_MPObjValNHua =   [788.0]


Set parameter MIPGap to value 0.05
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 634976 rows, 150727 columns and 1862815 nonzeros
Model fingerprint: 0x5c69b2c1
Variable types: 1 continuous, 150726 integer (143124 binary)
Coefficient statistics:
  Matrix range     [1e-01, 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 477983 rows and 131076 columns (presolve time = 5s) ...
Presolve removed 562733 rows and 139982 columns
Presolve time: 8.88s
Presolved: 72243 rows, 10745 columns, 222289 nonzeros
Variable types: 0 continuous, 10745 integer (8826 binary)

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

Root relaxation presolved: 10745 rows, 82988 columns, 233034 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    6.0610000e+03   0.000000e+00   3.524394e+04      9s
```

```
    6887    6.0687971e+03   0.000000e+00   1.580902e+05     10s
Concurrent spin time: 0.43s

Solved with dual simplex (primal model)

Root relaxation: objective 6.061000e+03, 5171 iterations, 1.21 seconds (1.42 work units)

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

     0     0 6061.00000    0  207          - 6061.00000      -     -   12s
     0     0 6061.00000    0  182          - 6061.00000      -     -   12s
     0     0 6061.00000    0  184          - 6061.00000      -     -   12s
     0     0 6061.00000    0  182          - 6061.00000      -     -   12s
     0     0 6061.00000    0  427          - 6061.00000      -     -   14s
     0     0 6061.00000    0  368          - 6061.00000      -     -   15s
     0     0 6061.00000    0  509          - 6061.00000      -     -   15s
     0     0 6061.00000    0  479          - 6061.00000      -     -   16s
     0     0 6061.00000    0  200          - 6061.00000      -     -   32s
H    0     0                6521.0000000 6061.00000  7.05%     -   33s
H    0     0                6261.0000000 6061.00000  3.19%     -   33s
     0     0 6061.00000    0  278 6261.00000 6061.00000  3.19%     -   33s

Cutting planes:
  Learned: 20
  Gomory: 6
  Cover: 468
  Implied bound: 62
  Clique: 126
  MIR: 344
  StrongCG: 10
  Flow cover: 17
  GUB cover: 195
  Zero half: 47
  RLT: 33
  Relax-and-lift: 98
  BQP: 8

Explored 1 nodes (49894 simplex iterations) in 33.44 seconds (47.21 work units)
Thread count was 8 (of 8 available processors)

Solution count 2: 6261 6521

Optimal solution found (tolerance 5.00e-02)
Best objective 6.261000000000e+03, best bound 6.061000000000e+03, gap 3.1944%
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 1153782 rows, 901813 columns and 7829634 nonzeros
Model fingerprint: 0xda53f6bc
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 1148737 rows and 900108 columns
Presolve time: 2.41s
Presolved: 5045 rows, 1705 columns, 13442 nonzeros
Variable types: 4 continuous, 1701 integer (975 binary)

Root relaxation: objective 5.472000e+03, 1528 iterations, 0.02 seconds (0.02 work units)

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

H    0     0                5472.0000000 15140.0000   177%     -    3s
     0     0        -    0     5472.00000 5472.00000  0.00%     -    3s

Explored 1 nodes (2244 simplex iterations) in 3.18 seconds (3.43 work units)
Thread count was 8 (of 8 available processors)

Solution count 1: 5472

Optimal solution found (tolerance 1.00e-08)
Best objective 5.472000000000e+03, best bound 5.472000000000e+03, gap 0.0000%
SP is solved
```

```
SP's optimal solution is'□5472

 Itr = 1
Collect_LB =  [788.0, 6261.0]
Collect_UB =  [11230.000000000004, 6512.000000000002]
Collect_Hua =  [0.0, 5221.0]
Collect_SPObjVal =  [5221.000000000002, 5472.000000000002]
Collect_MPObjValNHua =  [788.0, 1040.0]


Set parameter MIPGap to value 0.05
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 887579 rows, 163849 columns and 2679854 nonzeros
Model fingerprint: 0x2f81b669
Variable types: 1 continuous, 163848 integer (148668 binary)
Coefficient statistics:
  Matrix range     [1e-01, 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 692684 rows and 139590 columns (presolve time = 5s) ...
Presolve removed 710007 rows and 140153 columns (presolve time = 10s) ...
Presolve removed 781454 rows and 148690 columns
Presolve time: 13.13s
Presolved: 106125 rows, 15159 columns, 346673 nonzeros
Variable types: 0 continuous, 15159 integer (11336 binary)

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

Root relaxation presolved: 15159 rows, 121284 columns, 361832 nonzeros


Root simplex log...

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    6.3120000e+03   0.000000e+00   6.946088e+04     14s
   12342    6.3261663e+03   0.000000e+00   3.907429e+05     15s
   15943    6.3120000e+03   0.000000e+00   0.000000e+00     16s
   15943    6.3120000e+03   0.000000e+00   0.000000e+00     16s
Concurrent spin time: 0.57s

Solved with primal simplex

Root relaxation: objective 6.312000e+03, 15943 iterations, 2.76 seconds (3.44 work units)
Total elapsed time = 20.11s

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

     0     0 6312.00000    0  680          - 6312.00000      -     -   21s
     0     0 6312.00000    0  963          - 6312.00000      -     -   26s
     0     0 6312.00000    0  908          - 6312.00000      -     -   27s
     0     0 6312.00000    0  816          - 6312.00000      -     -   28s
     0     0 6312.00000    0  815          - 6312.00000      -     -   28s
     0     0 6312.00000    0  377          - 6312.00000      -     -   34s
     0     0 6312.00000    0  373          - 6312.00000      -     -   34s
     0     0 6312.00000    0  670          - 6312.00000      -     -   36s
     0     0 6312.00000    0  667          - 6312.00000      -     -   36s
     0     0 6312.00000    0  382          - 6312.00000      -     -   45s
     0     0 6312.00000    0  618          - 6312.00000      -     -   46s
     0     0 6312.00000    0  602          - 6312.00000      -     -   46s
     0     0 6312.00000    0  426          - 6312.00000      -     -   56s
     0     0 6312.00000    0  438          - 6312.00000      -     -   56s
     0     0 6312.00000    0  437          - 6312.00000      -     -   56s
     0     0 6312.00000    0  693          - 6312.00000      -     -   58s
     0     0 6312.00000    0  447          - 6312.00000      -     -   67s
     0     0 6312.00000    0  513          - 6312.00000      -     -   67s
     0     0 6312.00000    0  577          - 6312.00000      -     -   68s
     0     0 6312.00000    0  420          - 6312.00000      -     -   74s
     0     0 6312.00000    0  403          - 6312.00000      -     -   74s
     0     0 6312.00000    0  387          - 6312.00000      -     -   77s
     0     2 6312.00000    0  237          - 6312.00000      -     -   85s
     3     8 6312.00000    2  763          - 6312.00000      -  5850   90s
    11    16 6312.00000    4  867          - 6312.00000      -  4464  102s
    19    23 6312.00000    6  854          - 6312.00000      -  2970  108s
```

```
 332      23    29 6312.00000    7  756          - 6312.00000      -  3062  112s
 333      34    51 6312.00000    9  750          - 6312.00000      -  2683  121s
 334      52    76 6312.00000   13  745          - 6312.00000      -  2173  132s
 335      82   151 6312.00000   21  665          - 6312.00000      -  2295  147s
 336     209   286 6312.00000   53  659          - 6312.00000      -  1387  168s
 337     478   451 6312.00000   99  560          - 6312.00000      -   749  184s
 338     713   623 6312.00000  124  522          - 6312.00000      -   620  201s
 339     932  1096 6312.00000  179  537          - 6312.00000      -   550  224s
 340    1505  1455 6312.00000  231  536          - 6312.00000      -   400  243s
 341    1958  1456 6852.00000  243  387          - 6312.00000      -   352  297s
 342    1960  1457 6752.00000   63  577          - 6312.00000      -   351  323s
 343    1961  1458 6392.00000  300  372          - 6312.00000      -   351  362s
 344    1962  1459 6992.00000  236  790          - 6312.00000      -   351  379s
 345    1963  1459 6752.00000   63  778          - 6312.00000      -   351  407s
 346    1964  1460 6972.00000  194  895          - 6312.00000      -   351  428s
 347    1965  1461 6312.00000   36  544          - 6312.00000      -   351  457s
 348    1966  1461 6752.00000   21  907          - 6312.00000      -   350  499s
 349    1967  1462 6392.00000  441  967          - 6312.00000      -   350  627s
 350    1968  1463 6392.00000  442 1069          - 6312.00000      -   350  632s
 351  H 1968  1389                    6512.0000000 6312.00000  3.07%   350  653s
 352
 353  Cutting planes:
 354    Learned: 2
 355    Gomory: 5
 356    Cover: 390
 357    Implied bound: 550
 358    Projected implied bound: 57
 359    Clique: 97
 360    MIR: 156
 361    StrongCG: 332
 362    Flow cover: 573
 363    GUB cover: 76
 364    Zero half: 167
 365    RLT: 66
 366    Relax-and-lift: 136
 367    BQP: 11
 368
 369  Explored 1968 nodes (1115257 simplex iterations) in 653.81 seconds (1199.37 work units)
 370  Thread count was 8 (of 8 available processors)
 371
 372  Solution count 1: 6512
 373
 374  Optimal solution found (tolerance 5.00e-02)
 375  Best objective 6.512000000000e+03, best bound 6.312000000000e+03, gap 3.0713%
 376  Warning: linear constraint 382374 and linear constraint 634977 have the same name "ConSP25_1[0,0]"
 377  Set parameter MIPGap to value 1e-08
 378  Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
 379
 380  CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
 381  Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
 382
 383  Optimize a model with 1153782 rows, 901813 columns and 7829634 nonzeros
 384  Model fingerprint: 0xe45451d2
 385  Variable types: 441325 continuous, 460488 integer (456438 binary)
 386  Coefficient statistics:
 387    Matrix range     [1e-01, 1e+10]
 388    Objective range  [6e-05, 5e+01]
 389    Bounds range     [1e+00, 8e+01]
 390    RHS range        [8e-01, 1e+10]
 391  Warning: Model contains large matrix coefficients
 392  Warning: Model contains large rhs
 393          Consider reformulating model or setting NumericFocus parameter
 394          to avoid numerical issues.
 395  Presolve removed 1147852 rows and 899895 columns
 396  Presolve time: 2.90s
 397  Presolved: 5930 rows, 1918 columns, 15957 nonzeros
 398  Variable types: 4 continuous, 1914 integer (1082 binary)
 399  Found heuristic solution: objective 3852.0026652
 400
 401  Root relaxation: objective 5.472000e+03, 1804 iterations, 0.02 seconds (0.02 work units)
 402
 403      Nodes    |    Current Node    |     Objective Bounds      |     Work
 404   Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node Time
 405
 406  H    0     0                    5472.0000000 17260.0000   215%     -    3s
 407       0     0        -    0      5472.00000 5472.00000  0.00%     -    3s
 408
 409  Explored 1 nodes (2440 simplex iterations) in 3.86 seconds (3.50 work units)
 410  Thread count was 8 (of 8 available processors)
 411
 412  Solution count 2: 5472 3852
 413
 414  Optimal solution found (tolerance 1.00e-08)
 415  Best objective 5.472000000000e+03, best bound 5.472000000000e+03, gap 0.0000%
```

```
SP is solved
SP's optimal solution is'□5472

 Itr = 2
Collect_LB =  [788.0, 6261.0, 6512.0]
Collect_UB =  [11230.000000000004, 6512.000000000002, 6512.000000000002]
Collect_Hua =  [0.0, 5221.0, 5472.0]
Collect_SPObjVal =  [5221.000000000002, 5472.000000000002, 5472.000000000002]
Collect_MPObjValNHua =  [788.0, 1040.0, 1040.0]


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

~~~~~~~~~~judge = 2, SPObj_SPF = 5472.000000000002
Vessel i: 0:  pi: 12-19,  ai-di: 8-25,  gi_SP-gpi_SP: 0.000000-0.000000,  ai_SP-di: 8-25,  taoi-deltai: 8-25,  taoPi_SP-deltaPi_SP: 8-25,  betaNi: 17,  bi: 17
Vessel i: 1:  pi: 6-12,  ai-di: 14-24,  gi_SP-gpi_SP: 0.000000-0.000000,  ai_SP-di: 14-24,  taoi-deltai: 14-25,  taoPi_SP-deltaPi_SP: 14-25,  betaNi: 11,  bi: 11
Vessel i: 2:  pi: 20-26,  ai-di: 14-49,  gi_SP-gpi_SP: 0.000000-0.000000,  ai_SP-di: 14-49,  taoi-deltai: 14-47,  taoPi_SP-deltaPi_SP: 14-47,  betaNi: 33,  bi: 33
Vessel i: 3:  pi: 15-20,  ai-di: 22-48,  gi_SP-gpi_SP: 0.000000-0.000000,  ai_SP-di: 22-48,  taoi-deltai: 26-53,  taoPi_SP-deltaPi_SP: 26-53,  betaNi: 27,  bi: 27
Vessel i: 4:  pi: 20-26,  ai-di: 43-56,  gi_SP-gpi_SP: 1.000000-0.600000,  ai_SP-di: 48-56,  taoi-deltai: 48-58,  taoPi_SP-deltaPi_SP: 48-58,  betaNi: 10,  bi: 10
Vessel i: 5:  pi: 10-15,  ai-di: 35-75,  gi_SP-gpi_SP: 0.200000-0.600000,  ai_SP-di: 35-75,  taoi-deltai: 38-72,  taoPi_SP-deltaPi_SP: 38-72,  betaNi: 34,  bi: 34

round LB =  [788, 6261, 6512]
round UB =  [11230, 6512, 6512]
round Hua =  [0, 5221, 5472]
round SPObjVal =  [5221, 5472, 5472]
round MPObjValNHua =  [788, 1040, 1040]

Time: 944.000000
```