

```

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=4072
2
3 import sys; print('Python %s on %s' % (sys.version, sys.platform))
4 sys.path.extend(['E:\1 \ \ \ \ \ \3 \ \ \ \ \ \ \ \ \ \ \ \1 \ \ \ \ \ \ \ \ \ \ \ \1 \_LW_ \ \ \ \ \ \4 \ \ \ \ \ \3 python_code\9 Code for this
  paper', 'E:/1 \ \ \ \ \ \3 \ \ \ \ \ \ \ \ \ \ \ \1 \ \ \ \ \ \ \ \ \ \ \ \1 \_LW_ \ \ \ \ \ \4 \ \ \ \ \ \3 python_code/9 Code for this paper'])
5
6 PyDev console: starting.
7
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 \_LW_ \ \ \ \ \ \4 \ \ \ \ \ \3 python_code/9 Code for this paper/
  main_RO_BDC.py', wdir='E:/1 \ \ \ \ \ \3 \ \ \ \ \ \ \ \ \ \ \ \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)
14
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
17
18 Optimize a model with 515144 rows, 40692 columns and 1410688 nonzeros
19 Model fingerprint: 0x09f0577d
20 Variable types: 1 continuous, 40691 integer (40663 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 310186 rows and 17936 columns (presolve time = 5s) ...
31 Presolve removed 453674 rows and 28303 columns
32 Presolve time: 8.13s
33 Presolved: 61470 rows, 12389 columns, 193706 nonzeros
34 Variable types: 0 continuous, 12389 integer (12368 binary)
35
36 Deterministic concurrent LP optimizer: primal and dual simplex (primal and dual model)
37 Showing first log only...
38
39 Root relaxation presolved: 12389 rows, 73859 columns, 206095 nonzeros
40
41
42 Root simplex log...
43
44 Iteration Objective Primal Inf. Dual Inf. Time
45 0 7.9800000e+02 0.000000e+00 9.570000e+02 9s
46 Concurrent spin time: 0.00s
47
48 Solved with dual simplex (primal model)
49
50 Root relaxation: objective 7.980000e+02, 2935 iterations, 0.31 seconds (0.34 work units)
51
52 Nodes | Current Node | Objective Bounds | Work
53 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
54
55 0 0 798.00000 0 103 - 798.00000 - - 9s
56 0 0 798.00000 0 90 - 798.00000 - - 9s
57 H 0 0 3718.000000 798.00000 78.5% - 10s
58 0 0 798.00000 0 65 3718.00000 798.00000 78.5% - 10s
59 0 0 798.00000 0 36 3718.00000 798.00000 78.5% - 18s
60 H 0 0 2318.000000 798.00000 65.6% - 19s
61 H 0 0 2258.000000 798.00000 64.7% - 19s
62 0 0 798.00000 0 729 2258.00000 798.00000 64.7% - 21s
63 0 0 798.00000 0 581 2258.00000 798.00000 64.7% - 22s
64 H 0 0 1638.000000 798.00000 51.3% - 26s
65 0 0 798.00000 0 153 1638.00000 798.00000 51.3% - 27s
66 0 0 798.00000 0 173 1638.00000 798.00000 51.3% - 28s
67 0 0 798.00000 0 215 1638.00000 798.00000 51.3% - 30s
68 0 0 798.00000 0 223 1638.00000 798.00000 51.3% - 30s
69 0 0 798.00000 0 203 1638.00000 798.00000 51.3% - 33s
70 H 0 0 1518.000000 798.00000 47.4% - 34s
71 0 0 798.00000 0 218 1518.00000 798.00000 47.4% - 34s
72 H 0 0 1018.000000 798.00000 21.6% - 35s
73 0 0 798.00000 0 246 1018.00000 798.00000 21.6% - 35s
74 0 0 798.00000 0 29 1018.00000 798.00000 21.6% - 42s
75 0 0 798.00000 0 277 1018.00000 798.00000 21.6% - 45s
76 0 0 798.00000 0 656 1018.00000 798.00000 21.6% - 46s
77 0 0 798.00000 0 41 1018.00000 798.00000 21.6% - 48s
78 0 0 798.00000 0 292 1018.00000 798.00000 21.6% - 49s
79 0 0 798.00000 0 51 1018.00000 798.00000 21.6% - 50s

```

```

80 0 0 798.00000 0 113 1018.00000 798.00000 21.6% - 51s
81 0 0 798.00000 0 97 1018.00000 798.00000 21.6% - 52s
82 H 0 0 818.0000000 798.00000 2.44% - 53s
83 0 0 798.00000 0 169 818.00000 798.00000 2.44% - 53s
84 0 0 798.00000 0 591 818.00000 798.00000 2.44% - 54s
85 0 0 798.00000 0 26 818.00000 798.00000 2.44% - 62s
86 0 0 798.00000 0 417 818.00000 798.00000 2.44% - 64s
87 0 0 798.00000 0 299 818.00000 798.00000 2.44% - 64s
88 H 0 0 798.0000000 798.00000 0.00% - 65s
89 0 0 798.00000 0 35 798.00000 798.00000 0.00% - 66s
90
91 Cutting planes:
92 Cover: 67
93 Implied bound: 26
94 Clique: 504
95 MIR: 75
96 StrongCG: 64
97 GUB cover: 12
98 Zero half: 9
99 RLT: 63
100 Relax-and-lift: 15
101 BQP: 19
102
103 Explored 1 nodes (92122 simplex iterations) in 66.03 seconds (118.48 work units)
104 Thread count was 8 (of 8 available processors)
105
106 Solution count 8: 798 818 1018 ... 3718
107
108 Optimal solution found (tolerance 1.00e-10)
109 Best objective 7.980000000000e+02, best bound 7.980000000000e+02, gap 0.0000%
110 Set parameter MIPGap to value 1e-08
111 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
112
113 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
114 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
115
116 Optimize a model with 1540871 rows, 1208299 columns and 10558810 nonzeros
117 Model fingerprint: 0xae10b899
118 Variable types: 592971 continuous, 615328 integer (610603 binary)
119 Coefficient statistics:
120 Matrix range [1e-01, 1e+10]
121 Objective range [6e-05, 5e+01]
122 Bounds range [1e+00, 8e+01]
123 RHS range [8e-01, 1e+10]
124 Warning: Model contains large matrix coefficients
125 Warning: Model contains large rhs
126 Consider reformulating model or setting NumericFocus parameter
127 to avoid numerical issues.
128 Presolve removed 1536002 rows and 1206757 columns
129 Presolve time: 3.16s
130 Presolved: 4869 rows, 1542 columns, 12997 nonzeros
131 Variable types: 4 continuous, 1538 integer (885 binary)
132 Found heuristic solution: objective 3422.3669629
133
134 Root relaxation: objective 5.044132e+03, 1798 iterations, 0.03 seconds (0.04 work units)
135
136 Nodes | Current Node | Objective Bounds | Work
137 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
138
139 0 0 5044.13157 0 69 3422.36696 5044.13157 47.4% - 4s
140 H 0 0 4545.2426831 5044.13157 11.0% - 4s
141 H 0 0 4549.1315720 5044.13157 10.9% - 4s
142 0 0 5044.13157 0 62 4549.13157 5044.13157 10.9% - 4s
143 H 0 0 4980.2426831 5044.13157 1.28% - 4s
144 H 0 0 5044.1315720 5044.13157 0.00% - 4s
145 0 0 5044.13157 0 62 5044.13157 5044.13157 0.00% - 4s
146
147 Cutting planes:
148 Learned: 5
149 Gomory: 7
150 Cover: 3
151 Implied bound: 1
152 MIR: 8
153 Flow cover: 7
154 RLT: 4
155
156 Explored 1 nodes (2816 simplex iterations) in 4.29 seconds (4.63 work units)
157 Thread count was 8 (of 8 available processors)
158
159 Solution count 5: 5044.13 4980.24 4549.13 ... 3422.37
160
161 Optimal solution found (tolerance 1.00e-08)
162 Best objective 5.044131571994e+03, best bound 5.044131571994e+03, gap 0.0000%
163 SP is solved

```

```

164 SP's optimal solution is' 5044
165
166 Itr = 0
167 Collect_LB = [798.0]
168 Collect_UB = [10886.263143987097]
169 Collect_Hua = [0.0]
170 Collect_SPObjVal = [5044.131571993548]
171 Collect_MPObjValNHua = [798.0]
172
173
174 Set parameter TimeLimit to value 12000
175 Set parameter MIPGap to value 0.0005
176 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
177
178 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
179 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
180
181 Optimize a model with 519185 rows, 180636 columns and 1414764 nonzeros
182 Model fingerprint: 0x40cc639f
183 Variable types: 1 continuous, 180635 integer (180607 binary)
184 Coefficient statistics:
185 Matrix range [1e+00, 1e+10]
186 Objective range [1e+00, 2e+01]
187 Bounds range [1e+00, 1e+00]
188 RHS range [1e+00, 2e+10]
189 Warning: Model contains large matrix coefficients
190 Warning: Model contains large rhs
191 Consider reformulating model or setting NumericFocus parameter
192 to avoid numerical issues.
193 Presolve removed 350765 rows and 162961 columns (presolve time = 5s) ...
194 Presolve removed 470785 rows and 173288 columns
195 Presolve time: 8.44s
196 Presolved: 48400 rows, 7348 columns, 122681 nonzeros
197 Variable types: 0 continuous, 7348 integer (7327 binary)
198 Root relaxation presolved: 7348 rows, 55748 columns, 130029 nonzeros
199
200
201 Root simplex log...
202
203 Iteration Objective Primal Inf. Dual Inf. Time
204 0 handle free variables 9s
205 7000 5.8936053e+03 5.051732e+02 0.000000e+00 10s
206 8920 5.8424939e+03 0.000000e+00 0.000000e+00 10s
207 8920 5.8424939e+03 0.000000e+00 0.000000e+00 10s
208
209 Root relaxation: objective 5.842494e+03, 8920 iterations, 1.68 seconds (3.79 work units)
210
211 Nodes | Current Node | Objective Bounds | Work
212 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
213
214 0 0 5842.49390 0 999 - 5842.49390 - - 11s
215 0 0 5842.49390 0 1003 - 5842.49390 - - 11s
216 0 0 5842.49390 0 1025 - 5842.49390 - - 11s
217 0 0 5842.49390 0 1003 - 5842.49390 - - 11s
218 0 0 5842.54308 0 917 - 5842.54308 - - 12s
219 0 0 5842.54308 0 916 - 5842.54308 - - 12s
220 0 0 5862.13157 0 1981 - 5862.13157 - - 14s
221 0 0 5862.13157 0 800 - 5862.13157 - - 16s
222 0 0 5862.13157 0 786 - 5862.13157 - - 16s
223 0 0 5862.13157 0 960 - 5862.13157 - - 17s
224 0 0 5862.13157 0 1002 - 5862.13157 - - 18s
225 0 0 5862.13157 0 813 - 5862.13157 - - 21s
226 0 0 5862.13157 0 796 - 5862.13157 - - 22s
227 0 0 5862.13157 0 683 - 5862.13157 - - 23s
228 0 0 5862.13157 0 664 - 5862.13157 - - 24s
229 0 0 5862.13157 0 838 - 5862.13157 - - 25s
230 0 0 5862.13157 0 749 - 5862.13157 - - 26s
231 0 0 5862.13157 0 372 - 5862.13157 - - 31s
232 0 0 5862.13157 0 380 - 5862.13157 - - 31s
233 0 0 5862.13157 0 899 - 5862.13157 - - 34s
234 0 0 5862.13157 0 872 - 5862.13157 - - 34s
235 0 0 5862.13157 0 472 - 5862.13157 - - 43s
236 0 0 5862.13157 0 467 - 5862.13157 - - 43s
237 0 0 5862.13157 0 691 - 5862.13157 - - 45s
238 H 0 0 6082.1315720 5862.13157 3.62% - 51s
239 H 0 0 6042.1315720 5862.13157 2.98% - 51s
240 0 0 5862.13157 0 290 6042.13157 5862.13157 2.98% - 54s
241 0 0 5862.13157 0 273 6042.13157 5862.13157 2.98% - 54s
242 0 0 5862.13157 0 427 6042.13157 5862.13157 2.98% - 55s
243 0 0 5862.13157 0 451 6042.13157 5862.13157 2.98% - 56s
244 0 0 5862.13157 0 453 6042.13157 5862.13157 2.98% - 56s
245 0 0 5862.13157 0 801 6042.13157 5862.13157 2.98% - 57s
246 0 0 5862.13157 0 137 6042.13157 5862.13157 2.98% - 58s
247 0 0 5862.13157 0 458 6042.13157 5862.13157 2.98% - 58s

```

unknown

```
248 0 0 5862.13157 0 473 6042.13157 5862.13157 2.98% - 58s
249 0 0 5862.13157 0 462 6042.13157 5862.13157 2.98% - 58s
250 H 0 0 5942.1315720 5862.13157 1.35% - 58s
251 0 0 5862.13157 0 664 5942.13157 5862.13157 1.35% - 59s
252 0 0 5862.13157 0 637 5942.13157 5862.13157 1.35% - 59s
253 0 0 5942.13157 0 597 5942.13157 5942.13157 0.00% - 59s
254
255 Cutting planes:
256 Learned: 107
257 Gomory: 54
258 Cover: 86
259 Implied bound: 26
260 Clique: 141
261 MIR: 84
262 StrongCG: 23
263 Zero half: 40
264 RLT: 11
265 Relax-and-lift: 73
266 BQP: 1
267
268 Explored 1 nodes (111098 simplex iterations) in 59.31 seconds (109.33 work units)
269 Thread count was 8 (of 8 available processors)
270
271 Solution count 3: 5942.13 6042.13 6082.13
272
273 Optimal solution found (tolerance 5.00e-04)
274 Best objective 5.942131571994e+03, best bound 5.942131571994e+03, gap 0.0000%
275 Set parameter MIPGap to value 1e-08
276 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
277
278 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
279 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
280
281 Optimize a model with 1540871 rows, 1208299 columns and 10558810 nonzeros
282 Model fingerprint: 0xcelb5161
283 Variable types: 592971 continuous, 615328 integer (610603 binary)
284 Coefficient statistics:
285 Matrix range [1e-01, 1e+10]
286 Objective range [6e-05, 5e+01]
287 Bounds range [1e+00, 8e+01]
288 RHS range [8e-01, 1e+10]
289 Warning: Model contains large matrix coefficients
290 Warning: Model contains large rhs
291 Consider reformulating model or setting NumericFocus parameter
292 to avoid numerical issues.
293 Presolve removed 1535448 rows and 1206637 columns
294 Presolve time: 3.23s
295 Presolved: 5423 rows, 1662 columns, 14503 nonzeros
296 Variable types: 6 continuous, 1656 integer (946 binary)
297 Found heuristic solution: objective 3592.9885856
298
299 Root relaxation: objective 5.142443e+03, 1869 iterations, 0.03 seconds (0.03 work units)
300
301 Nodes | Current Node | Objective Bounds | Work
302 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
303
304 0 0 5142.44341 0 15 3592.98859 5142.44341 43.1% - 4s
305 H 0 0 5139.3211873 5142.44341 0.06% - 4s
306 H 0 0 5140.0989651 5142.44341 0.05% - 4s
307 * 0 0 0 5140.2100762 5140.21008 0.00% - 4s
308
309 Cutting planes:
310 Cover: 1
311 Implied bound: 1
312 MIR: 7
313 Flow cover: 1
314 Zero half: 1
315 RLT: 1
316 Relax-and-lift: 1
317
318 Explored 1 nodes (2657 simplex iterations) in 4.39 seconds (4.62 work units)
319 Thread count was 8 (of 8 available processors)
320
321 Solution count 4: 5140.21 5140.1 5139.32 3592.99
322
323 Optimal solution found (tolerance 1.00e-08)
324 Best objective 5.140210076214e+03, best bound 5.140210076214e+03, gap 0.0000%
325 SP is solved
326 SP's optimal solution is'□5140
327
328 Itr = 1
329 Collect_LB = [798.0, 5942.131571993548]
330 Collect_UB = [10886.263143987097, 6038.210076213887]
331 Collect_Hua = [0.0, 5044.131571993548]
```

```

332 Collect_SPObjVal = [5044.131571993548, 5140.210076213887]
333 Collect_MPObjValNHua = [798.0, 898.0]
334
335
336 Set parameter TimeLimit to value 12000
337 Set parameter MIPGap to value 0.0005
338 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
339
340 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
341 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
342
343 Optimize a model with 519186 rows, 180636 columns and 1414779 nonzeros
344 Model fingerprint: 0x22271cd6
345 Variable types: 1 continuous, 180635 integer (180607 binary)
346 Coefficient statistics:
347   Matrix range    [1e+00, 1e+10]
348   Objective range [1e+00, 2e+01]
349   Bounds range   [1e+00, 1e+00]
350   RHS range      [1e+00, 2e+10]
351 Warning: Model contains large matrix coefficients
352 Warning: Model contains large rhs
353   Consider reformulating model or setting NumericFocus parameter
354   to avoid numerical issues.
355 Presolve removed 351462 rows and 163046 columns (presolve time = 5s) ...
356 Presolve removed 471155 rows and 173336 columns
357 Presolve time: 8.66s
358 Presolved: 48031 rows, 7300 columns, 121757 nonzeros
359 Variable types: 1 continuous, 7299 integer (7278 binary)
360 Root relaxation presolved: 7300 rows, 55331 columns, 129057 nonzeros
361
362
363 Root simplex log...
364
365 Iteration   Objective    Primal Inf.   Dual Inf.    Time
366      0    handle free variables                      9s
367    6498    6.0082101e+03  0.000000e+00  0.000000e+00  10s
368    6498    6.0082101e+03  0.000000e+00  0.000000e+00  10s
369
370 Root relaxation: objective 6.008210e+03, 6498 iterations, 1.07 seconds (2.29 work units)
371 Total elapsed time = 11.20s
372
373   Nodes | Current Node | Objective Bounds | Work
374 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
375
376   0   0 6008.21008   0 179    -6008.21008   -   - 11s
377   0   0 6008.21008   0 178    -6008.21008   -   - 11s
378   0   0 6008.21008   0 1020   -6008.21008   -   - 13s
379   0   0 6008.21008   0 1123   -6008.21008   -   - 14s
380   0   0 6008.21008   0 1098   -6008.21008   -   - 14s
381   0   0 6008.21008   0 1097   -6008.21008   -   - 14s
382   0   0 6008.21008   0 820    -6008.21008   -   - 15s
383   0   0 6008.21008   0 812    -6008.21008   -   - 15s
384   0   0 6008.21008   0 226    -6008.21008   -   - 18s
385   0   0 6008.21008   0 631    -6008.21008   -   - 19s
386   0   0 6008.21008   0 628    -6008.21008   -   - 19s
387   0   0 6008.21008   0 356    -6008.21008   -   - 24s
388   0   0 6008.21008   0 355    -6008.21008   -   - 24s
389   0   0 6008.21008   0 497    -6008.21008   -   - 25s
390   0   0 6008.21008   0 386    -6008.21008   -   - 32s
391   0   0 6008.21008   0 368    -6008.21008   -   - 32s
392   0   0 6008.21008   0 368    -6008.21008   -   - 34s
393   0   2 6008.21008   0 364    -6008.21008   -   - 43s
394   1   4 6008.21008   1 465    -6008.21008   - 8006 45s
395  11  16 6008.21008   4 693    -6008.21008   - 4248 52s
396  19  24 6008.21008   6 1427   -6008.21008   - 4476 55s
397  32  41 6008.21008   9 1236   -6008.21008   - 3485 61s
398  44  53 infeasible  10    -6008.21008   - 3400 65s
399  71  82 6008.21008  11 489    -6008.21008   - 2616 71s
400 135 143 infeasible  17    -6008.21008   - 1931 76s
401 202 257 6008.21008  34 459    -6008.21008   - 1598 81s
402 357 406 6008.21008   4 1015   -6008.21008   - 1071 85s
403 * 420 367      167 7108.2100762 6008.21008 15.5% 912 85s
404 546 301 6008.21008   5 1404 7108.21008 6008.21008 15.5% 761 91s
405 * 581 301      38 7088.2100762 6008.21008 15.2% 733 91s
406 * 692 301      38 7068.2100762 6008.21008 15.0% 655 91s
407 * 704 301      44 7028.2100762 6008.21008 14.5% 644 91s
408 720 433 6008.21008   6 1339 7028.21008 6008.21008 14.5% 651 106s
409 H 722 359      6508.2100762 6008.21008 7.68% 681 106s
410 936 548 6168.21008   8 956 6508.21008 6008.21008 7.68% 605 112s
411 H 1103 490      6268.2100762 6008.21008 4.15% 529 112s
412 H 1114 488      6188.2100762 6008.21008 2.91% 524 112s
413 H 1213 488      6068.2100762 6008.21008 0.99% 506 112s
414 H 1300 127      6048.2100762 6008.21008 0.66% 484 114s
415 1301 110 6028.21008 109 368 6048.21008 6008.21008 0.66% 483 117s

```

```

416
417 Cutting planes:
418   Learned: 65
419   Gomory: 11
420   Cover: 493
421   Implied bound: 86
422   Projected implied bound: 71
423   Clique: 279
424   MIR: 16
425   StrongCG: 4
426   Flow cover: 326
427   GUB cover: 15
428   Zero half: 87
429   RLT: 20
430   Relax-and-lift: 229
431   BQP: 1
432
433 Explored 1305 nodes (716427 simplex iterations) in 119.96 seconds (363.10 work units)
434 Thread count was 8 (of 8 available processors)
435
436 Solution count 9: 6048.21 6068.21 6188.21 ... 7108.21
437
438 Optimal solution found (tolerance 5.00e-04)
439 Best objective 6.048210076214e+03, best bound 6.048210076214e+03, gap 0.0000%
440 Set parameter MIPGap to value 1e-08
441 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
442
443 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
444 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
445
446 Optimize a model with 1540871 rows, 1208299 columns and 10558810 nonzeros
447 Model fingerprint: 0x86bfa3d9
448 Variable types: 592971 continuous, 615328 integer (610603 binary)
449 Coefficient statistics:
450   Matrix range    [1e-01, 1e+10]
451   Objective range [6e-05, 5e+01]
452   Bounds range    [1e+00, 8e+01]
453   RHS range       [8e-01, 1e+10]
454 Warning: Model contains large matrix coefficients
455 Warning: Model contains large rhs
456   Consider reformulating model or setting NumericFocus parameter
457   to avoid numerical issues.
458 Presolve removed 1535678 rows and 1206683 columns
459 Presolve time: 3.32s
460 Presolved: 5193 rows, 1616 columns, 13838 nonzeros
461 Variable types: 6 continuous, 1610 integer (923 binary)
462 Found heuristic solution: objective 3625.7982387
463
464 Root relaxation: objective 5.162443e+03, 1983 iterations, 0.04 seconds (0.03 work units)
465
466   Nodes | Current Node | Objective Bounds | Work
467 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
468
469   0   0 5162.44341   0 14 3625.79824 5162.44341 42.4% - 4s
470 H   0   0           5159.3211873 5162.44341 0.06% - 4s
471 H   0   0           5160.0989651 5162.44341 0.05% - 4s
472 *   0   0           0 5160.2100762 5160.21008 0.00% - 4s
473
474 Cutting planes:
475   Cover: 1
476   Implied bound: 2
477   MIR: 8
478   Flow cover: 1
479   Zero half: 1
480   RLT: 1
481   Relax-and-lift: 1
482
483 Explored 1 nodes (2554 simplex iterations) in 4.47 seconds (4.63 work units)
484 Thread count was 8 (of 8 available processors)
485
486 Solution count 4: 5160.21 5160.1 5159.32 3625.8
487
488 Optimal solution found (tolerance 1.00e-08)
489 Best objective 5.160210076214e+03, best bound 5.160210076214e+03, gap 0.0000%
490 SP is solved
491 SP's optimal solution is '□5160
492
493 Itr = 2
494 Collect_LB = [798.0, 5942.131571993548, 6048.210076213887]
495 Collect_UB = [10886.263143987097, 6038.210076213887, 6038.210076213887]
496 Collect_Hua = [0.0, 5044.131571993548, 5140.210076213887]
497 Collect_SPObjVal = [5044.131571993548, 5140.210076213887, 5160.210076213887]
498 Collect_MPObjValNHua = [798.0, 898.0, 908.0]
499

```

```
500
501 Ops, stop iteration
502 Values adopted from the ltr-1' th iteration, and ltr = {2}, judgeCount = {1}
503
504 ~~~~~judgeCount = 1, SPObj_SPF = 5140.210076213887
505 Vessel i: 0: pi: 0-7, ai-di: 6-39, gi_SP-gpi_SP: 0.000000-0.000000, ai_SP-di: 6-39, taoi-deltai: 6-37, taoPi_SP-deltaPi_SP: 6-37, betaNi: 31
, bi: 31
506 Vessel i: 1: pi: 14-21, ai-di: 5-22, gi_SP-gpi_SP: 0.000000-0.000000, ai_SP-di: 5-22, taoi-deltai: 5-20, taoPi_SP-deltaPi_SP: 5-20, betaNi: 15
, bi: 15
507 Vessel i: 2: pi: 7-14, ai-di: 8-41, gi_SP-gpi_SP: 0.000000-0.000000, ai_SP-di: 8-41, taoi-deltai: 8-39, taoPi_SP-deltaPi_SP: 8-39, betaNi: 31
, bi: 31
508 Vessel i: 3: pi: 27-34, ai-di: 15-28, gi_SP-gpi_SP: 0.000000-0.000000, ai_SP-di: 15-28, taoi-deltai: 15-26, taoPi_SP-deltaPi_SP: 15-26,
betaNi: 11, bi: 11
509 Vessel i: 4: pi: 14-20, ai-di: 11-41, gi_SP-gpi_SP: 0.900000-0.343013, ai_SP-di: 15-41, taoi-deltai: 21-37, taoPi_SP-deltaPi_SP: 21-37,
betaNi: 16, bi: 16
510 Vessel i: 5: pi: 20-27, ai-di: 29-53, gi_SP-gpi_SP: 0.500000-1.000000, ai_SP-di: 33-53, taoi-deltai: 33-41, taoPi_SP-deltaPi_SP: 33-41,
betaNi: 8, bi: 8
511 Vessel i: 6: pi: 14-20, ai-di: 44-65, gi_SP-gpi_SP: 0.400000-0.456987, ai_SP-di: 48-65, taoi-deltai: 46-51, taoPi_SP-deltaPi_SP: 48-51,
betaNi: 5, bi: 5
512
513 round LB = [798, 5942, 6048]
514 round UB = [10886, 6038, 6038]
515 round Hua = [0, 5044, 5140]
516 round SPObjVal = [5044, 5140, 5160]
517 round MPObjValNHua = [798, 898, 908]
518
519 OptimalObj = 6048.210076213887
520 Time: 550.000000
521
522
523
524
```