


```

80 0 0 952.00000 0 345 952.00000 952.00000 0.00% - 32s
81
82 Cutting planes:
83 Gomory: 1
84 Cover: 26
85 Implied bound: 493
86 Clique: 4
87 MIR: 11
88 StrongCG: 6
89 GUB cover: 11
90 Zero half: 2
91 RLT: 46
92
93 Explored 1 nodes (50684 simplex iterations) in 32.78 seconds (50.26 work units)
94 Thread count was 8 (of 8 available processors)
95
96 Solution count 5: 952 1052 1272 ... 1772
97
98 Optimal solution found (tolerance 1.00e-10)
99 Best objective 9.5200000000000e+02, best bound 9.5200000000000e+02, gap 0.0000%
100 Set parameter MIPGap to value 1e-08
101 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
102
103 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
104 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
105
106 Optimize a model with 335520 rows, 11221 columns and 691105 nonzeros
107 Model fingerprint: 0x4e9e49e7
108 Variable types: 28 continuous, 11193 integer (6468 binary)
109 Coefficient statistics:
110 Matrix range [1e-01, 1e+10]
111 Objective range [6e-05, 5e+01]
112 Bounds range [1e+00, 1e+00]
113 RHS range [8e-01, 1e+10]
114 Warning: Model contains large matrix coefficients
115 Warning: Model contains large rhs
116 Consider reformulating model or setting NumericFocus parameter
117 to avoid numerical issues.
118 Presolve removed 330430 rows and 9615 columns
119 Presolve time: 0.32s
120 Presolved: 5090 rows, 1606 columns, 13574 nonzeros
121 Variable types: 6 continuous, 1600 integer (933 binary)
122 Found heuristic solution: objective 4154.9688264
123
124 Root relaxation: objective 5.873048e+03, 1955 iterations, 0.03 seconds (0.03 work units)
125
126 Nodes | Current Node | Objective Bounds | Work
127 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
128
129 0 0 5873.04809 0 118 4154.96883 5873.04809 41.3% - 0s
130 H 0 0 5636.2579725 5873.04809 4.20% - 0s
131 H 0 0 5782.4688264 5864.67847 1.42% - 0s
132 0 0 5864.67847 0 58 5782.46883 5864.67847 1.42% - 0s
133 H 0 0 5862.9410487 5864.67847 0.03% - 0s
134 0 0 cutoff 0 5862.94105 5862.94105 0.00% - 0s
135
136 Cutting planes:
137 Learned: 2
138 Gomory: 9
139 Cover: 6
140 Implied bound: 4
141 Clique: 7
142 MIR: 3
143 Flow cover: 6
144 Zero half: 7
145 RLT: 6
146 Relax-and-lift: 2
147 PSD: 3
148
149 Explored 1 nodes (2951 simplex iterations) in 0.53 seconds (0.74 work units)
150 Thread count was 8 (of 8 available processors)
151
152 Solution count 4: 5862.94 5782.47 5636.26 4154.97
153
154 Optimal solution found (tolerance 1.00e-08)
155 Best objective 5.862941048662e+03, best bound 5.862941048662e+03, gap 0.0000%
156 SP is solved
157 SP's optimal solution is '[5862
158
159 Itr = 0
160 Collect_LB = [952.0]
161 Collect_UB = [12677.88209732316]
162 Collect_Hua = [0.0]
163 Collect_SPObjVal = [5862.94104866158]

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164 Collect_MPObjValNHua = [952.0]
165
166
167 Set parameter MIPGap to value 1e-10
168 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
169
170 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
171 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
172
173 Optimize a model with 492948 rows, 180636 columns and 1346857 nonzeros
174 Model fingerprint: 0x15067c06
175 Variable types: 1 continuous, 180635 integer (180607 binary)
176 Coefficient statistics:
177   Matrix range    [1e+00, 1e+10]
178   Objective range [1e+00, 2e+01]
179   Bounds range    [1e+00, 1e+00]
180   RHS range       [1e+00, 2e+10]
181 Warning: Model contains large matrix coefficients
182 Warning: Model contains large rhs
183   Consider reformulating model or setting NumericFocus parameter
184   to avoid numerical issues.
185 Presolve removed 303856 rows and 160627 columns (presolve time = 5s) ...
186 Presolve removed 460365 rows and 172592 columns
187 Presolve time: 9.20s
188 Presolved: 32583 rows, 8044 columns, 111386 nonzeros
189 Variable types: 0 continuous, 8044 integer (8024 binary)
190
191 Root simplex log...
192
193 Iteration   Objective      Primal Inf.   Dual Inf.    Time
194      0  6.8149410e+03  1.059000e+03  0.000000e+00   9s
195    5224  6.8149410e+03  0.000000e+00  0.000000e+00  10s
196
197 Root relaxation: objective 6.814941e+03, 5224 iterations, 0.24 seconds (0.47 work units)
198
199   Nodes |   Current Node |   Objective Bounds |   Work
200 Expl Unexpl | Obj Depth IntInf | Incumbent  BestBd  Gap | It/Node Time
201
202    0  0 6814.94105  0  23  - 6814.94105  -  -  9s
203    0  0 6814.94105  0  58  - 6814.94105  -  - 11s
204    0  0 6814.94105  0 420  - 6814.94105  -  - 13s
205    0  0 6814.94105  0 293  - 6814.94105  -  - 14s
206    0  0 6814.94105  0 379  - 6814.94105  -  - 14s
207    0  0 6814.94105  0 415  - 6814.94105  -  - 15s
208    0  0 6814.94105  0  24  - 6814.94105  -  - 17s
209    0  0 6814.94105  0 152  - 6814.94105  -  - 18s
210    0  0 6814.94105  0 462  - 6814.94105  -  - 19s
211    0  0 6814.94105  0 544  - 6814.94105  -  - 20s
212    0  0 6814.94105  0 483  - 6814.94105  -  - 20s
213    0  0 6814.94105  0  96  - 6814.94105  -  - 24s
214    0  0 6814.94105  0 388  - 6814.94105  -  - 27s
215    0  0 6814.94105  0 386  - 6814.94105  -  - 33s
216    0  0 6814.94105  0 500  - 6814.94105  -  - 34s
217    0  0 6814.94105  0 498  - 6814.94105  -  - 34s
218    0  0 6814.94105  0 619  - 6814.94105  -  - 39s
219 H  0  0 10494.941049 6814.94105 35.1%  - 40s
220    0  0 6814.94105  0 619 10494.9410 6814.94105 35.1%  - 40s
221 H  0  0 8354.9410487 6814.94105 18.4%  - 43s
222    0  2 6814.94105  0 575 8354.94105 6814.94105 18.4%  - 44s
223    1  4 6815.40710  1 1891 8354.94105 6814.94105 18.4% 9628 46s
224    7 12 6818.87886  3 1014 8354.94105 6816.30706 18.4% 3902 50s
225   23 27 6834.94105  6 760 8354.94105 6816.75012 18.4% 2925 56s
226 H 73 74 8254.9410487 6816.75012 17.4% 1403 58s
227   90 103 6834.94105 26 1118 8254.94105 6816.75012 17.4% 1203 60s
228 H 113 118 8154.9410487 6816.75012 16.4% 1004 60s
229 H 149 171 8094.9410487 6816.75012 15.8% 780 61s
230   517 506 6834.94105 146 922 8094.94105 6816.75012 15.8% 256 65s
231 H 518 355 7414.9410487 6816.75012 8.07% 256 65s
232 H 539 321 7394.9410487 6816.75012 7.82% 247 66s
233 H 562 310 7374.9410487 6816.75012 7.57% 241 66s
234   840 552 6834.94105 216 847 7374.94105 6816.75012 7.57% 183 70s
235 H 971 222 6954.9410487 6816.75012 1.99% 193 74s
236   972 218 infeasible 259 6954.94105 6816.75012 1.99% 245 83s
237   976 208 infeasible 259 6954.94105 6819.34211 1.95% 347 86s
238 H 1000 199 6934.9410487 6819.34211 1.67% 415 89s
239  1004 32 6819.34211  0 415 6934.94105 6819.34211 1.67% 449 94s
240  1009 35 6833.70702  0 528 6934.94105 6833.70702 1.46% 446 95s
241
242 Cutting planes:
243   Learned: 1
244   Cover: 21
245   Clique: 10
246   MIR: 20
247   StrongCG: 42

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248 RLT: 1
249 BQP: 1
250
251 Explored 1075 nodes (625916 simplex iterations) in 98.19 seconds (203.39 work units)
252 Thread count was 8 (of 8 available processors)
253
254 Solution count 10: 6934.94 6954.94 7374.94 ... 10494.9
255
256 Optimal solution found (tolerance 1.00e-10)
257 Best objective 6.934941048662e+03, best bound 6.934941048662e+03, gap 0.0000%
258 Set parameter MIPGap to value 1e-08
259 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
260
261 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
262 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
263
264 Optimize a model with 335520 rows, 11221 columns and 691105 nonzeros
265 Model fingerprint: 0xba44cb1d
266 Variable types: 28 continuous, 11193 integer (6468 binary)
267 Coefficient statistics:
268   Matrix range    [1e-01, 1e+10]
269   Objective range [6e-05, 5e+01]
270   Bounds range    [1e+00, 1e+00]
271   RHS range       [8e-01, 1e+10]
272 Warning: Model contains large matrix coefficients
273 Warning: Model contains large rhs
274   Consider reformulating model or setting NumericFocus parameter
275   to avoid numerical issues.
276 Presolve removed 329635 rows and 9414 columns
277 Presolve time: 0.25s
278 Presolved: 5885 rows, 1807 columns, 15811 nonzeros
279 Variable types: 6 continuous, 1801 integer (1042 binary)
280 Found heuristic solution: objective 4534.1077153
281
282 Root relaxation: objective 6.197473e+03, 1648 iterations, 0.02 seconds (0.02 work units)
283
284   Nodes | Current Node | Objective Bounds | Work
285 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
286
287   0   0 6197.47254   0 59 4534.10772 6197.47254 36.7% - 0s
288 H   0   0           6103.5439290 6197.47254 1.54% - 0s
289   0   0 6191.39938   0 27 6103.54393 6191.39938 1.44% - 0s
290 H   0   0           6191.1910487 6191.39938 0.00% - 0s
291 H   0   0           6191.3333333 6191.39938 0.00% - 0s
292   0   0 cutoff   0 6191.33333 6191.33333 0.00% - 0s
293
294 Cutting planes:
295   Learned: 1
296   Gomory: 4
297   Cover: 10
298   Implied bound: 15
299   Clique: 6
300   MIR: 4
301   StrongCG: 1
302   Flow cover: 4
303   GUB cover: 1
304   Zero half: 2
305   RLT: 14
306   Relax-and-lift: 3
307   PSD: 2
308
309 Explored 1 nodes (2781 simplex iterations) in 0.49 seconds (0.67 work units)
310 Thread count was 8 (of 8 available processors)
311
312 Solution count 4: 6191.33 6191.19 6103.54 4534.11
313
314 Optimal solution found (tolerance 1.00e-08)
315 Best objective 6.19133333333e+03, best bound 6.19133333333e+03, gap 0.0000%
316 SP is solved
317 SP's optimal solution is'□6191
318
319 Itr = 1
320 Collect_LB = [952.0, 6934.94104866158]
321 Collect_UB = [12677.88209732316, 7263.333333333334]
322 Collect_Hua = [0.0, 5862.94104866158]
323 Collect_SPObjVal = [5862.94104866158, 6191.333333333334]
324 Collect_MPObjValNHua = [952.0, 1072.0]
325
326
327 Set parameter MIPGap to value 1e-10
328 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
329
330 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
331 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads

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332
333 Optimize a model with 492948 rows, 180636 columns and 1346857 nonzeros
334 Model fingerprint: 0x8dcaae97
335 Variable types: 1 continuous, 180635 integer (180607 binary)
336 Coefficient statistics:
337   Matrix range   [1e+00, 1e+10]
338   Objective range [1e+00, 2e+01]
339   Bounds range   [1e+00, 1e+00]
340   RHS range      [1e+00, 2e+10]
341 Warning: Model contains large matrix coefficients
342 Warning: Model contains large rhs
343   Consider reformulating model or setting NumericFocus parameter
344   to avoid numerical issues.
345 Presolve removed 304337 rows and 160697 columns (presolve time = 5s) ...
346 Presolve removed 460467 rows and 172619 columns
347 Presolve time: 9.17s
348 Presolved: 32481 rows, 8017 columns, 111002 nonzeros
349 Variable types: 0 continuous, 8017 integer (7997 binary)
350
351 Root simplex log...
352
353 Iteration   Objective      Primal Inf.   Dual Inf.   Time
354      0  7.1483333e+03  1.014000e+03  0.000000e+00  9s
355    5187  7.1483333e+03  0.000000e+00  0.000000e+00 10s
356
357 Root relaxation: objective 7.148333e+03, 5187 iterations, 0.27 seconds (0.51 work units)
358
359 Nodes | Current Node | Objective Bounds | Work
360 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
361
362  0  0 7148.33333  0 22 - 7148.33333 - - 9s
363  0  0 7148.33333  0 125 - 7148.33333 - - 11s
364  0  0 7148.33333  0 95 - 7148.33333 - - 11s
365  0  0 7148.33333  0 54 - 7148.33333 - - 12s
366  0  0 7148.33333  0 183 - 7148.33333 - - 12s
367  0  0 7148.33333  0 146 - 7148.33333 - - 12s
368  0  0 7148.33333  0 210 - 7148.33333 - - 17s
369  0  0 7148.33333  0 432 - 7148.33333 - - 18s
370  0  0 7148.33333  0 431 - 7148.33333 - - 18s
371  0  0 7148.33333  0 468 - 7148.33333 - - 19s
372  0  0 7148.33333  0 499 - 7148.33333 - - 26s
373  0  0 7148.33333  0 580 - 7148.33333 - - 27s
374  0  0 7148.33333  0 443 - 7148.33333 - - 27s
375 H  0  0 11088.333333 7148.33333 35.5% - 28s
376  0  0 7148.33333  0 134 11088.3333 7148.33333 35.5% - 30s
377 H  0  0 8748.3333333 7148.33333 18.3% - 31s
378  0  2 7148.33333  0 63 8748.33333 7148.33333 18.3% - 33s
379  3  4 7148.33333  2 196 8748.33333 7148.33333 18.3% 1472 35s
380 13 14 7151.03815  4 1953 8748.33333 7148.33333 18.3% 4104 41s
381 21 16 7151.15236  5 1769 8748.33333 7148.33333 18.3% 3631 47s
382 25 20 7152.15985  6 2526 8748.33333 7148.33333 18.3% 4686 50s
383 H 31 26 8668.3333333 7148.33333 17.5% 4104 53s
384 44 43 7168.33333  9 1368 8668.33333 7148.33333 17.5% 3213 55s
385 H 65 66 8628.3333333 7148.33333 17.2% 2300 56s
386 H 77 66 8508.3333333 7148.33333 16.0% 1944 56s
387 169 141 7153.36891  7 1761 8508.33333 7148.33333 16.0% 1013 60s
388 189 162 7168.33333  51 2041 8508.33333 7148.33333 16.0% 1116 65s
389 228 200 7188.33333  55 1577 8508.33333 7148.33333 16.0% 1098 70s
390 325 277 7188.33333  92 1537 8508.33333 7148.33333 16.0% 884 76s
391 H 406 244 7708.3333333 7148.33333 7.26% 774 78s
392 437 232 7188.33333 122 1313 7708.33333 7148.33333 7.26% 779 81s
393 459 242 7188.37963 124 1146 7708.33333 7148.33333 7.26% 860 85s
394 492 256 7208.33333 132 1281 7708.33333 7148.33333 7.26% 906 92s
395 581 329 7208.33333 152 1243 7708.33333 7148.33333 7.26% 878 96s
396 687 384 7212.09907 170 1770 7708.33333 7148.33333 7.26% 797 101s
397 756 407 7268.33333 175 1382 7708.33333 7148.33333 7.26% 788 105s
398 H 759 212 7388.3333333 7148.33333 3.25% 789 105s
399 767 221 infeasible 178 7388.33333 7149.18142 3.24% 798 111s
400 837 245 7161.03069  9 1173 7388.33333 7149.18142 3.24% 839 115s
401 1043 220 7208.33333 159 134 7388.33333 7150.15419 3.22% 735 125s
402 1244 302 infeasible 17 7388.33333 7188.33333 2.71% 71.5 130s
403 1474 294 7290.36896  30 179 7388.33333 7188.33333 2.71% 135 135s
404 1859 302 cutoff 76 7388.33333 7248.33333 1.89% 169 140s
405 2240 417 infeasible 91 7388.33333 7248.33333 1.89% 203 145s
406 * 2366 332 63 7348.3333333 7251.88693 1.31% 210 146s
407 H 2381 235 7328.3333333 7253.34985 1.02% 213 148s
408 H 2397 181 7308.3333333 7258.03088 0.69% 216 148s
409 2489 114 7288.33333  30 356 7308.33333 7268.33333 0.55% 228 150s
410
411 Cutting planes:
412   Learned: 3
413
414 Explored 2714 nodes (1526762 simplex iterations) in 151.71 seconds (373.31 work units)
415 Thread count was 8 (of 8 available processors)

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```

416
417 Solution count 10: 7308.33 7328.33 7348.33 ... 11088.3
418
419 Optimal solution found (tolerance 1.00e-10)
420 Best objective 7.308333333333e+03, best bound 7.308333333333e+03, gap 0.0000%
421 Set parameter MIPGap to value 1e-08
422 Gurobi Optimizer version 10.0.2 build v10.0.2rc0 (win64)
423
424 CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
425 Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
426
427 Optimize a model with 335520 rows, 11221 columns and 691105 nonzeros
428 Model fingerprint: 0x92b4362f
429 Variable types: 28 continuous, 11193 integer (6468 binary)
430 Coefficient statistics:
431   Matrix range    [1e-01, 1e+10]
432   Objective range [6e-05, 5e+01]
433   Bounds range    [1e+00, 1e+00]
434   RHS range       [8e-01, 1e+10]
435 Warning: Model contains large matrix coefficients
436 Warning: Model contains large rhs
437   Consider reformulating model or setting NumericFocus parameter
438   to avoid numerical issues.
439 Presolve removed 329753 rows and 9444 columns
440 Presolve time: 0.27s
441 Presolved: 5767 rows, 1777 columns, 15436 nonzeros
442 Variable types: 6 continuous, 1771 integer (1025 binary)
443 Found heuristic solution: objective 4358.1077153
444
445 Root relaxation: objective 6.017333e+03, 1662 iterations, 0.03 seconds (0.02 work units)
446
447   Nodes | Current Node | Objective Bounds | Work
448 Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
449
450    0    0 6017.33333    0 30 4358.10772 6017.33333 38.1% - 0s
451 H  0    0          5986.4410487 6017.33333 0.52% - 0s
452 H  0    0          6012.6910487 6017.33333 0.08% - 0s
453 H  0    0          6015.1910487 6017.33333 0.04% - 0s
454    0    0 6016.66667    9 6015.19105 6016.66667 0.02% - 0s
455    0    0 6016.66667   12 6015.19105 6016.66667 0.02% - 0s
456    0    0 6016.44105    7 6015.19105 6016.44105 0.02% - 0s
457 H  0    0          6015.3333333 6016.44105 0.02% - 0s
458    0    0 cutoff    0    6015.33333 6015.33333 0.00% - 0s
459
460 Cutting planes:
461   Learned: 1
462   MIR: 1
463
464 Explored 1 nodes (2482 simplex iterations) in 0.46 seconds (0.72 work units)
465 Thread count was 8 (of 8 available processors)
466
467 Solution count 5: 6015.33 6015.19 6012.69 ... 4358.11
468
469 Optimal solution found (tolerance 1.00e-08)
470 Best objective 6.015333333333e+03, best bound 6.015333333333e+03, gap 0.0000%
471 SP is solved
472 SP's optimal solution is '[6015
473
474 Itr = 2
475 Collect LB = [952.0, 6934.94104866158, 7308.333333333334]
476 Collect UB = [12677.88209732316, 7263.333333333334, 7132.333333333334]
477 Collect Hua = [0.0, 5862.94104866158, 6191.333333333334]
478 Collect SPObjVal = [5862.94104866158, 6191.333333333334, 6015.333333333334]
479 Collect MPObjValNHua = [952.0, 1072.0, 1117.0]
480
481
482 Ops, stop iteration
483 Values adopted from the Itr' th iteration, and Itr = {2}, judgeCount = {2}
484
485 ~~~~~judge = 2, SPObj_SPF = 6015.333333333334
486 Vessel i: 0: pi: 0-6, ai-di: 1-14, gi_SP-gpi_SP: 0.000000-0.000000, ai_SP-di: 1-14, taoi-delta: 1-14, taoPi_SP-deltaPi_SP: 1-10, betaNi: 13
, bi: 13
487 Vessel i: 1: pi: 0-7, ai-di: 15-32, gi_SP-gpi_SP: 0.000000-0.000000, ai_SP-di: 15-32, taoi-delta: 15-30, taoPi_SP-deltaPi_SP: 16-30, betaNi:
15, bi: 15
488 Vessel i: 2: pi: 14-21, ai-di: 16-50, gi_SP-gpi_SP: 0.000000-0.000000, ai_SP-di: 16-50, taoi-delta: 16-48, taoPi_SP-deltaPi_SP: 16-48,
betaNi: 32, bi: 32
489 Vessel i: 3: pi: 7-14, ai-di: 24-56, gi_SP-gpi_SP: 0.000000-0.000000, ai_SP-di: 24-56, taoi-delta: 24-54, taoPi_SP-deltaPi_SP: 25-54, betaNi
: 30, bi: 30
490 Vessel i: 4: pi: 21-27, ai-di: 18-45, gi_SP-gpi_SP: 0.300000-0.200000, ai_SP-di: 19-45, taoi-delta: 21-32, taoPi_SP-deltaPi_SP: 21-32,
betaNi: 11, bi: 11
491 Vessel i: 5: pi: 21-26, ai-di: 33-60, gi_SP-gpi_SP: 0.500000-1.000000, ai_SP-di: 37-60, taoi-delta: 35-44, taoPi_SP-deltaPi_SP: 37-44,
betaNi: 9, bi: 9
492 Vessel i: 6: pi: 27-34, ai-di: 25-75, gi_SP-gpi_SP: 1.000000-0.600000, ai_SP-di: 35-75, taoi-delta: 43-75, taoPi_SP-deltaPi_SP: 43-75,
betaNi: 32, bi: 32

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unknown

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493
494 round LB = [952, 6935, 7308]
495 round UB = [12678, 7263, 7132]
496 round Hua = [0, 5863, 6191]
497 round SPObjVal = [5863, 6191, 6015]
498 round MPObjValNHua = [952, 1072, 1117]
499
500 OptimalObj = 7308.333333333334
501 Time: 338.000000
502
503
504
505
```