```
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=31908
       import sys; print('Python %s on %s' % (sys.version, sys.platform))
       sys.path.extend([F:\\\] ===\\\\3 python_code\\9 Code for this paper', 'E:/1 ===\\3 ===\\1 ===\\1 ===\\1 ===\\1 ===\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 ==\\1 =\\1 ==\\1 ==\\1 ==\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 =\\1 
  6
       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
  8
       >>> runfile('E:/1 = 1 = 1/3 = 1 = 1/4 = 1 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 = 1/4 
        paper')
10
       Backend TkAgg is interactive backend. Turning interactive mode on.
       Waiting 5s.....
12
       Optimize the ./R_30_1.xlsx instance
13
14
15
       Set parameter TimeLimit to value 1200
16
17
       Set parameter PoolSolutions to value 3
        Set parameter PoolGap to value 0.05
19
       Set parameter PoolSearchMode to value 2
      Gurobi Optimizer version 11.0.0 build v11.0.0rc2 (win64 - Windows 10.0 (19045.2))
20
21
       CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
23
       Thread count: 4 physical cores, 8 logical processors, using up to 8 threads
24
       Optimize a model with 2196102 rows, 266910 columns and 6557250 nonzeros
       Model fingerprint: 0x1de26dea
26
       Variable types: 0 continuous, 266910 integer (228900 binary)
27
28
       Coefficient statistics:
         Matrix range [1e+00, 5e+05]
29
30
         Objective range [1e+00, 1e+00]
31
         Bounds range [1e+00, 1e+00]
         RHS range
                                     [1e+00, 2e+06]
       Presolve removed 2069295 rows and 14390 columns
33
34
       Presolve time: 0.99s
35
       Presolved: 126807 rows, 252520 columns, 380689 nonzeros
       Variable types: 0 continuous, 252520 integer (214510 binary)
       Root relaxation presolved: 96696 rows, 252921 columns, 287268 nonzeros
37
38
39
       Deterministic concurrent LP optimizer: primal and dual simplex
40
       Showing primal log only...
41
42
       Concurrent spin time: 0.00s
43
44
       Solved with dual simplex
45
46
       Root relaxation: objective 8.827352e+02, 6876 iterations, 0.92 seconds (0.95 work units)
48
            Nodes | Current Node | Objective Bounds
                                                                                                              Work
        Expl Unexpl | Obj Depth IntInf | Incumbent BestBd Gap | It/Node Time
49
50
51
                    0 882.73521 0 3774
                                                                       - 882.73521
                                                                                                                 5s
52
             0
                    0 936.22558
                                              0.3828
                                                                       - 936.22558
                                                                                                                 8s
53
             0
                    0 936.73385
                                              0 3644
                                                                       - 936.73385
                                                1760.0000000 936.73385 46.8% -
54
       Η
               0
                                                                                                                 - 16s
55
                                               1667.0000000 936.73385 43.8%
      Η
             0
                      0
                    0 938.71440  0 3622 1667.00000 938.71440 43.7%
56
             0
                                                                                                                          - 16s
57
                    0 938.86814
                                                0 3819 1667.00000 938.86814 43.7%
                                              0 3819 1667.00000 939.01675 43.7%
58
                    0 939.01675
                                                                                                                           - 17s
59
                    0 939.05342
                                              0 3819 1667.00000 939.05342 43.7%
             0
                                                                                                                           - 17s
60
             0
                    0 939.09994
                                                0 3819 1667.00000 939.09994 43.7%
                                                                                                                           - 17s
                    0 939.11292
                                                0 3819 1667.00000 939.11292 43.7%
                                                                                                                           - 17s
             0
                    0 939.14616
                                                0 3819 1667.00000 939.14616 43.7%
62
                                                                                                                           - 17s
                                                0 3819 1667.00000 939.15450 43.7%
63
                    0 939 15450
                                                                                                                           - 17s
             0
64
                    0.947.77607
                                                0 3500 1667.00000 947.77607 43.1%
                                                                                                                           - 19s
                                                0\ 3666\ 1667.00000\ \ 948.33823\ \ 43.1\%
65
                    0 948.33823
                                                                                                                               21s
                                                0 3670 1667.00000 948.43413 43.1%
                                                                                                                           - 21s
                    0 948.43413
66
             0
67
             0
                    0 948.43509
                                                0.3668 1667.00000 948.43509 43.1%
                                                                                                                           - 229
                                                                                                                               24s
68
             0
                    0 956.11856
                                                0 2837 1667.00000 956.11856 42.6%
69
                    0 956.65073
                                                0 2977 1667.00000 956.65073 42.6%
                                                                                                                               2.6s
                                                0 3009 1667 00000 956 76304 42.6%
70
             0
                    0.956.76304
                                                                                                                               26s
71
             0
                    0 956.83355
                                                0 3031 1667.00000 956.83355 42.6%
                                                                                                                               26s
                    0 956.84084
                                                0 3037 1667.00000 956.84084 42.6%
73
             0
                    0 959.72001
                                                0 2727 1667.00000 959.72001 42.4%
                                                                                                                               28s
                                                0 2956 1667.00000 960.50520 42.4%
74
             0
                    0.960.50520
                                                                                                                               30s
75
                    0 960.70897
                                                0 3036 1667.00000 960.70897 42.4%
                                                                                                                                30s
76
                    0 960.73054
                                                 0 2971 1667.00000 960.73054 42.4%
                                                                                                                               30s
                                                0 2917 1667.00000 961.38445 42.3%
77
             0
                    0 961.38445
                                                                                                                               31s
78
             0
                    0 961.59423
                                                0 2848 1667.00000 961.59423 42.3%
                                                                                                                           - 34s
             0
                    0 961.67351
                                                0 2965 1667.00000 961.67351 42.3%
79
```

```
0 961.68987 0 3002 1667.00000 961.68987 42.3%
                                                            - 34s
          0 962.09623
                        0 2676 1667.00000 962.09623 42.3%
                                                            - 35s
                        0 2975 1667.00000 962.18511 42.3%
          0.962.18511
 82
                                                            - 37s
83
          0 962.21208
                        0 2997 1667.00000 962.21208 42.3%
                                                              37s
          0 962.53494
                        0 3091 1667.00000 962.53494 42.3%
85
          0 962.60177
                        0 3046 1667.00000 962.60177 42.3%
                                                            - 40s
       0
                        0 2933 1667.00000 962.62358 42.3%
          0.962.62358
86
       0
                                                            - 41s
87
          0 962.85109
                        0 2834 1667.00000 962.85109 42.2%
                                                            - 42s
       0
88
       0
           0 962.87949
                        0 2519 1667.00000 962.87949 42.2%
           2 963.01800 0 2479 1667.00000 963.01800 42.2%
                                                            - 46s
89
       0
          29 1015.75755 12 2725 1667.00000 965.05561 42.1% 269 50s
90
      38
91
                         1601.0000000 965.05561 39.7% 243 75s
    H 42
      268 268 1031.21054 69 2672 1601.00000 965.05561 39.7% 43.5 80s
93
      469 454 1081.63996 118 2308 1601.00000 965.05561 39.7% 44.5 85s
94
      714 705 1093.22176 164 2007 1601.00000 965.05561 39.7% 47.5 90s
                           1599.0000000 965.05561 39.6% 32.6 105s
96
     1085 979 1011.74125 23 48503 1599.00000 965.05561 39.6% 32.5 110s
     1087 980 1042.04038 197 2403 1599.00000 965.05561 39.6% 32.5 130s
97
   H 1087 931
98
                          1595.0000000 1518.00000 4.83% 32.5 166s
     1089 842 1518.00000 234 459 1595.00000 1518.00000 4.83% 32.4 208s
100
     1090 842 1518 00000 197 366 1595 00000 1518 00000 4.83% 32.4 228s
     1091 843 1518.00000 248 400 1595.00000 1518.00000 4.83% 32.4 235s
101
           844 1518.05886 80 405 1595.00000 1518.05886 4.82% 32.3 261s
102
     1092
103
     1093 802 1518.05954 169 347 1595.00000 1518.05954 4.82% 32.3 270s
     1094 803 1519.54559 144 391 1595.00000 1519.54559 4.73% 32.3 286s
104
105
     1095 804 1521.91323 37 444 1595.00000 1521.91323 4.58% 32.2 291s
     1097 805 1522.08874 187 524 1595.00000 1522.08874 4.57% 32.2 297s
                          1594.0000000 1522.08874 4.51% 32.2 298s
107 H 1097 764
     1099 765 1522.08914 131 779 1594.00000 1522.08914 4.51% 32.1 305s
108
           766 1522.08914 178 520 1594.00000 1522.08914 4.51% 32.1 313s
109
110
     1102
           767 1524.00000 236 727 1594.00000 1524.00000 4.39% 32.0 316s
     1104 769 1525.04251 83 739 1594.00000 1525.04251 4.33% 32.0 337s
111
112 H 1104 730
                          1590.0000000 1525.04251 4.09% 32.0 354s
           730 1526.42379 168 431 1590.00000 1526.42379 4.00% 32.0 359s
113
     1105
     1106
           731 1528.03505 148 373 1590.00000 1528.03505 3.90% 31.9 361s
114
           697 1529.38254 211 757 1590.00000 1529.38254 3.81% 31.8 369s
115
     1111
116
           698 1529.69464 121 723 1590.00000 1529.69464 3.79% 31.8 371s
     1114 664 1529.73400 102 1076 1590.00000 1529.73400 3.79% 31.7 376s
117
     1118 667 1530.96667 235 1082 1590.00000 1530.96667 3.71% 31.6 380s
118
119
     1120 668 1531.07230 137 1075 1590.00000 1531.07230 3.71% 31.5 385s
     1125 638 1531.55874 106 1177 1590.00000 1531.55874 3.68% 31.4 390s
121
     1128 640 1531.57404 99 1172 1590.00000 1531.57404 3.67% 31.3 395s
     1130 \ \ 641 \ 1531.57467 \ \ 63 \ 1153 \ 1590.00000 \ 1531.57467 \ \ 3.67\% \ \ 31.3 \ \ 400s
122
123 H 1132 609
                          1587.0000000 1533.10301 3.40% 31.2 402s
           581 1533.10301 234 922 1587.00000 1533.10301 3.40% 31.1 408s
124
           582 1533.10301 80 834 1587.00000 1533.10301 3.40% 31.1 410s
125
     1137
           588 1533.10301 204 918 1587.00000 1533.10301 3.40% 30.8 418s
126
     1146
127
     1148
           589 1533.15338 116 786 1587.00000 1533.15338 3.39% 30.8 426s
128
           592 1533.20040 104 845 1587.00000 1533.20040 3.39% 30.6 434s
     1153
           593 1533.29670 34 874 1587.00000 1533.29670 3.38% 30.6 436s
129
     1154
130
     1157
           595 1533.43770 12 1110 1587.00000 1533.43770 3.38% 30.5 440s
     1161 598 1533.45828 42 1112 1587.00000 1533.45828 3.37% 30.4 448s
                          1585.0000000 1533.58518 3.24% 30.4 455s
132
    H 1161 567
     1163 568 1533.61392 158 1111 1585.00000 1533.61392 3.24% 30.4 462s
133
134
           571 1533.62682 117 1105 1585.00000 1533.62682 3.24% 30.3 471s
135
     1168
           571 1533.71459 157 933 1585.00000 1533.71459 3.24% 30.2 476s
136
           573 1533.73514 50 1120 1585.00000 1533.73514 3.23% 30.2 480s
     1171
137
     1174
           544 1533.73818 37 1141 1585.00000 1533.73818 3.23% 30.1 490s
138
           545 1533.84934 73 1136 1585.00000 1533.84934 3.23% 30.1 504s
139
     1176
           546 1533.88012 129 1228 1585.00000 1533.88012 3.23% 30.0 518s
           546 1533.91223 155 1266 1585.00000 1533.91223 3.22% 30.0 534s
140
     1177
141
           547 1533.92122 61 1337 1585.00000 1533.92122 3.22% 30.0 539s
     1178
           548 1533.92478 26 1320 1585.00000 1533.92478 3.22% 30.0 547s
143
           548 1533.92755 107 1309 1585.00000 1533.92755 3.22% 29.9 561s
     1180
           550 1533.92904 174 1241 1585.00000 1533.92904 3.22% 29.9 566s
144
     1182
           550 1533.92925 259 1260 1585.00000 1533.92925 3.22% 29.9 600s
145
     1183
146
     1184
           551 1534.02624 196 1236 1585.00000 1534.02624 3.22% 29.8 614s
           552 1534.05255 23 1241 1585.00000 1534.05255 3.21% 29.8 628s
147
     1185
148
     1186
           552 1534.05880 220 1117 1585.00000 1534.05880 3.21% 29.8 632s
           553 1534.06053 197 1237 1585.00000 1534.06053 3.21% 29.7 643s
149
           554 1534.06152 222 1230 1585.00000 1534.06152 3.21% 29.7 647s
150
     1188
           555 1534.06276 197 1347 1585.00000 1534.06276 3.21% 29.7 652s
151
     1190
152
           527 1534.06286 248 1262 1585.00000 1534.06286 3.21% 29.6 678s
     1191
153
           499 1534.15174 80 1208 1585.00000 1534.15174 3.21% 29.6 710s
154
           500 1534 18216 169 1232 1585 00000 1534 18216 3 21% 29 6 731s
     1193
155
     1196
           502 1534.21059 93 1074 1585.00000 1534.21059 3.20% 29.5 738s
156
     1197
           503 1534.21256 187 1081 1585.00000 1534.21256 3.20% 29.5 740s
157
     1200
           505 1534.21553 178 1124 1585.00000 1534.21553 3.20% 29.4 749s
158
           505 1534.31788 70 1175 1585.00000 1534.31788 3.20% 29.4 758s
     1201
159
     1202
           506 1534.35638 236 1404 1585.00000 1534.35638 3.20% 29.4 764s
160
           507 1534.36800 124 1335 1585.00000 1534.36800 3.19% 29.4 765s
           510 1534.38057 163 1375 1585.00000 1534.38057 3.19% 29.2 776s
161
     1208
           511 1534.45447 195 1309 1585.00000 1534.45447 3.19% 29.2 791s
162
     1209
           511 1534.48307 176 1192 1585.00000 1534.48307 3.19% 29.2 802s
163
     1210
```

```
1211 512 1534.49565 211 1301 1585.00000 1534.49565 3.19% 29.2 811s
164
165
      1213 513 1534.50459 139 1196 1585.00000 1534.50459 3.19% 29.1 816s
           515 1534 50646 141 1169 1585 00000 1534 50646 3 19% 29.1 822s
166
      1215
167
           515 1534.56168 106 1312 1585.00000 1534.56168 3.18% 29.0 825s
           517 1534.64667 235 1122 1585.00000 1534.64667 3.18% 29.0 832s
169
           519 1534.68531 100 1035 1585.00000 1534.68531 3.17% 28.9 835s
      1221
170
           520 1534.68618 208 1054 1585.00000 1534.68618 3.17% 28.9 841s
      1223
171
      1225
           521 1534.79251 106 1063 1585.00000 1534.79251 3.17% 28.8 848s
172
      1226
            522 1534.81811 37 1086 1585.00000 1534.81811 3.17% 28.8 850s
           523 1534.82966 99 1165 1585.00000 1534.82966 3.17% 28.8 857s
173
      1228
           526 1534.83237 233 1072 1585.00000 1534.83237 3.17% 28.7 865s
174
      1232
175
            527 1534.92946 227 1168 1585.00000 1534.92946 3.16% 28.6 870s
      1233
176
      1235
            528 1534.96605 13 1053 1585.00000 1534.96605 3.16% 28.6 881s
           529 1534 97194 234 1067 1585 00000 1534 97194 3.16% 28.6 890s
177
      1236
178
      1238
           530 1534.97534 48 1166 1585.00000 1534.97534 3.16% 28.5 897s
            531 1534.97572 123 1154 1585.00000 1534.97572 3.16% 28.5 930s
179
      1239
180
           531 1535.06497 50 1197 1585.00000 1535.06497 3.15% 28.5 962s
      1240
           532 1535 09974 11 939 1585 00000 1535 09974 3 15% 28 5 970s
181
      1241
182
      1244
           534 1535.22145 49 1075 1585.00000 1535.22145 3.14% 28.4 977s
183
      1245
           535 1535.24730 77 1102 1585.00000 1535.24730 3.14% 28.4 981s
           536 1535.24730 31 1124 1585.00000 1535.24730 3.14% 28.3 985s
184
      1247
185
      1248
           537 1535.89777 116 1121 1585.00000 1535.89777 3.10% 28.3 1013s
            537 1535.90753 96 1011 1585.00000 1535.90753 3.10% 28.3 1022s
186
      1249
187
      1250
           538 1535.91660 62 1270 1585.00000 1535.91660 3.10% 28.3 1033s
188
           539 1535.92315 37 1004 1585.00000 1535.92315 3.10% 28.2 1043s
      1251
189
      1252
           539 1536.03334 142 967 1585.00000 1536.03334 3.09% 28.2 1050s
190
      1254
           541 1536.03334 34 1101 1585.00000 1536.03334 3.09% 28.2 1057s
191
      1255
           541 1536.69378 198 1106 1585.00000 1536.69378 3.05% 28.1 1083s
192
      1256
           542 1536.80704 169 1435 1585.00000 1536.80704 3.04% 28.1 1096s
193
      1257
            543 1536.80704 12 1231 1585.00000 1536.80704 3.04% 28.1 1101s
194
      1259
           544 1536.80704 24 1225 1585.00000 1536.80704 3.04% 28.0 1107s
195
           545 1536.80704 240 1216 1585.00000 1536.80704 3.04% 28.0 1112s
      1260
196
      1261
           545 1536.80729 42 1221 1585.00000 1536.80729 3.04% 28.0 1115s
            547 1536.80729 158 1192 1585.00000 1536.80729 3.04% 28.0 1122s
197
      1263
198
      1265
           548 1536.84485 206 1080 1585.00000 1536.84485 3.04% 27.9 1125s
199
      1270
           551 1536.94555 49 1148 1585.00000 1536.94555 3.03% 27.8 1130s
200
      1274
           554 1536.94568 37 1303 1585.00000 1536.94568 3.03% 27.7 1137s
201
      1275
           555 1537.49183 73 1374 1585.00000 1537.49183 3.00% 27.7 1145s
           559 1537,59305 105 1466 1585,00000 1537,59305 2,99% 27.6 1150s
202
      1281
203
      1283
            560 1537.59342 259 1510 1585.00000 1537.59342 2.99% 27.5 1158s
            561 1537.66624 196 1441 1585.00000 1537.66624 2.99% 27.5 1161s
204
205
           562 1537.67705 220 1470 1585.00000 1537.67705 2.99% 27.5 1165s
      1286
           566 1537.67759 80 1343 1585.00000 1537.67759 2.99% 27.3 1174s
206
      1292
207
      1293
           567 1537.68657 169 1487 1585.00000 1537.68657 2.99% 27.3 1177s
208
      1295
           568 1537.69606 37 1232 1585.00000 1537.69606 2.98% 27.3 1180s
                           1584.0000000 1537.69606 2.92% 27.3 1180s
209 H 1295 536
      1299 539 1538.42496 131 1361 1584.00000 1538.42496 2.88% 27.2 1188s
210
211
      1300
           539 1538.42496 178 1395 1584.00000 1538.42496 2.88% 27.2 1190s
212 H 1303 510
                           1582.0000000 1538.42496 2.75% 27.1 1193s
      1306 512 1538.42496 148 1432 1582.00000 1538.42496 2.75% 27.0 1195s
213
214
215 Cutting planes:
216
     Learned: 391
      Gomory: 29
217
218
     Lift-and-project: 25
219
      Cover: 71
      Implied bound: 133
220
221
      Clique: 34
      MIR: 804
222
223
      Mixing: 1
224
      StrongCG: 236
225
      Flow cover: 1589
226
      Zero half: 140
227
      RLT: 41
228
      Relax-and-lift: 3563
229
230
231
    Explored 1309 nodes (427718 simplex iterations) in 1200.36 seconds (511.97 work units)
232
    Thread count was 8 (of 8 available processors)
233
234
    Solution count 3: 1582 1584 1585
235
236
    Time limit reached
237
    Best objective 1.582000000000e+03, best bound 1.53900000000e+03, gap 2.7181%
238
239 Output one feasible solution with limited computation time
240
241 Optimization was stopped with status 9
242
243 Number of solution stored: 3
244
       1582 1584 1585
245
246 \text{ Obj} = 1582.0
247
```

```
248 Solutions:
249
         The total pi = 488.0
250
         The total duration time in berth stage = 192.0
251
         The total duration time in quay crane scheduling stage = 58.0
252
         The total departure time in berth stage= 858.0
253
         The total departure time in quay crane scheduling stage = 724.0
254
         The total wasted crane work hour according OC0= 10.0
255
         The last depature time in quay crane scheduling stage = 63.0
256
257
     The specific solution are as follows:
                                                                                                                                                  taoPi_SP-deltaPi_SP:
258
        Vessel i: 0:
                       li: 4,
                                    pi: 4-8,
                                                           ai-di: 16-23.
                                                                                    taoi-deltai: 16-22.
                                                                                                                     periodi: 6,
      16-18,
                                  periodPi: 2,
                                                                     c i: 1581864,
                                                                                                            dowork: 1581864,
                                                                                                                                                         fa i: 3
259
                                                                                       taoi-deltai: 10-19,
        Vessel i: 1:
                                    pi: 26-30,
                                                              ai-di: 10-20,
                                                                                                                        periodi: 9,
                                                                                                                                                    taoPi SP-deltaPi SP
     : 10-12.
                                 neriodPi: 2.
                                                                     c i: 2372796,
                                                                                                           dowork: 2636440,
                                                                                                                                                         fa i: 3
2.60
        Vessel i: 2:
                       li: 4.
                                    pi: 30-34,
                                                              ai-di: 13-18,
                                                                                       taoi-deltai: 13-18,
                                                                                                                        periodi: 5,
                                                                                                                                                    taoPi_SP-deltaPi_SP
                                  periodPi: 1,
                                                                    c_i: 1318220,
                                                                                                            dowork: 1318220,
       13-14.
                                                                                                                                                         fa i: 3
                                                                                  taoi-deltai: 5-12,
261
        Vessel i: 3:
                       li: 5,
                                    pi: 9-14,
                                                           ai-di: 5-14,
                                                                                                                                               taoPi SP-deltaPi SP: 5-7
                                                                                                                   periodi: 7.
                          periodPi: 2,
                                                                                                   dowork: 1845508.
                                                             c_i: 1845508,
                                                                                                                                                  fa_i: 4
                                                                                                                                                    taoPi SP-deltaPi SP
262
        Vessel i: 4:
                       li: 5,
                                    pi: 29-34,
                                                              ai-di: 21-24,
                                                                                       taoi-deltai: 21-25,
                                                                                                                        periodi: 4,
       21-22.
                                 periodPi: 1,
                                                                    c i: 1054576,
                                                                                                           dowork: 1318220,
                                                                                                                                                         fa i: 4
                                                                                                                    periodi: 9.
263
        Vessel i: 5:
                                    pi: 6-12,
                                                           ai-di: 25-32,
                                                                                    taoi-deltai: 25-34,
                                                                                                                                                  taoPi\_SP\text{-}deltaPi\_SP\text{:}
                       li: 6.
                                                                   c_i: 2372796,
                                                                                                           dowork: 2372796,
                                  periodPi: 2,
      25-27.
                                                                                                                                                         fa_i: 5
264
        Vessel i: 6:
                                                              ai-di: 4-7,
                                                                                    taoi-deltai: 4-9,
                                                                                                                                               taoPi_SP-deltaPi_SP: 4-5
                                    pi: 26-30.
                                                                                                                  periodi: 5,
                         periodPi: 1,
                                                             c i: 1318220,
                                                                                                  dowork: 1318220,
                                                                                                                                                 fa i: 3
        Vessel i: 7:
                                    pi: 18-23.
                                                                                                                                                    taoPi SP-deltaPi_SP
265
                                                             ai-di: 21-29,
                                                                                       taoi-deltai: 21-29,
                                                                                                                        periodi: 8,
                       li: 5.
       21-24,
                                  periodPi: 3,
                                                                     c_i: 2109152,
                                                                                                           dowork: 2372796,
                                                                                                                                                         fa_i: 4
                                                                                       taoi-deltai: 62-66,
                                                                                                                                                    taoPi SP-deltaPi SP
        Vessel i: 8:
                       li: 4.
                                    pi: 10-14,
                                                              ai-di: 62-67,
                                                                                                                        periodi: 4,
                                                                    c_i: 1054576,
                                 periodPi: 1,
                                                                                                           dowork: 1186398,
       62-63.
                                                                                                                                                         fa i: 3
                                                                                                                                               taoPi_SP-deltaPi_SP: 7-9
                                                           ai-di: 7-14,
                                                                                  taoi-deltai: 7-12,
267
        Vessel i: 9:
                                    pi: 4-9,
                                                                                                                   periodi: 5,
                          periodPi: 2,
                                                                                                  dowork: 1318220,
                                                             c i: 1318220,
                                                                                                                                                  fa_i: 4
268
        Vessel i: 10:
                          li: 4,
                                      pi: 29-33,
                                                                ai-di: 27-38,
                                                                                         taoi-deltai: 33-42,
                                                                                                                           periodi: 9,
                                                                                                                                                      taoPi SP-
                                                                               c i: 2372796,
      deltaPi SP: 33-35,
                                          periodPi: 2,
                                                                                                                     dowork: 2636440,
                                                                                                                                                                   fa i: 3
                                                                                                                                                  taoPi_SP-deltaPi_SP: 3
269
        Vessel i: 11:
                          li: 4,
                                      pi: 14-18,
                                                                ai-di: 3-9,
                                                                                       taoi-deltai: 3-7,
                                                                                                                     periodi: 4,
                            periodPi: 1,
                                                                c i: 1054576,
                                                                                                      dowork: 1054576,
                                                                                                                                                    fa_i: 3
                                      pi: 24-29.
                                                                                          taoi-deltai: 28-33,
270
        Vessel i: 12:
                          li: 5.
                                                                ai-di: 28-34.
                                                                                                                          periodi: 5,
                                                                                                                                                      taoPi SP-
                                           periodPi: 1,
                                                                               c i: 1318220,
                                                                                                                      dowork: 1581864,
     deltaPi SP: 28-29,
                                                                                                                                                                   fa_i: 4
271
        Vessel i: 13:
                          li: 6,
                                       pi: 18-24,
                                                                ai-di: 31-38,
                                                                                         taoi-deltai: 31-37,
                                                                                                                         periodi: 6,
                                                                                                                                                      taoPi SP-
                                                                               c_i: 1581864,
      deltaPi SP: 31-33,
                                           periodPi: 2,
                                                                                                                      dowork: 1845508,
                                                                                                                                                                   fa i: 5
                                                                                                                                                    taoPi_SP-deltaPi_SP
        Vessel i: 14:
                                      pi: 0-4,
                                                              ai-di: 10-18,
272
                                                                                       taoi-deltai: 10-16,
                                                                                                                        periodi: 6,
                          1i: 4.
      : 10-12.
                                 periodPi: 2,
                                                                     c_i: 1581864,
                                                                                                           dowork: 1581864,
                                                                                                                                                         fa_i: 3
                                                                                       taoi-deltai: 39-47,
273
        Vessel i: 15:
                                      pi: 8-14,
                                                              ai-di: 39-45,
                                                                                                                                                    taoPi_SP-deltaPi_SP
                                                                                                                        periodi: 8.
       39-41,
                                 periodPi: 2,
                                                                    c i: 2109152,
                                                                                                           dowork: 2109152,
                                                                                                                                                         fa i: 5
                                                                                       taoi-deltai: 8-12,
                                                                                                                                                    taoPi SP-deltaPi SP
        Vessel i: 16:
                          li: 4,
                                      pi: 30-34.
                                                                ai-di: 8-14.
                                                                                                                        periodi: 4.
                                                                                                         dowork: 1318220,
       8-9.
                               periodPi: 1,
                                                                  c i: 1054576,
                                                                                                                                                      fa_i: 3
        Vessel i: 17:
                                                                                       taoi-deltai: 52-61,
                                                                                                                                                    taoPi_SP-deltaPi_SP
                          li: 5.
                                      pi: 9-14,
                                                              ai-di: 52-61,
                                                                                                                        periodi: 9,
                                                                                                           dowork: 2372796,
       52-54.
                                 periodPi: 2.
                                                                    c i: 2372796.
                                                                                                                                                         fa i: 4
                                                                                                                        periodi: 9.
276
                                                              ai-di: 21-28,
                                                                                       taoi-deltai: 23-32,
                                                                                                                                                    taoPi_SP-deltaPi_SP
        Vessel i: 18:
                          li: 6,
                                      pi: 0-6,
                                                                    c_i: 2372796,
                                                                                                                                                         fa_i: 5
       23-28,
                                 periodPi: 5,
                                                                                                           dowork: 2372796,
                                                                                       taoi-deltai: 2-11,
                                                                                                                        periodi: 9.
        Vessel i: 19:
                          li: 4,
                                      pi: 22-26,
                                                                ai-di: 2-12,
                                                                                                                                                    taoPi SP-deltaPi SP
                              periodPi: 3,
                                                                                                        dowork: 2372796,
                                                                  c i: 2372796,
       2-5.
                                                                                                                                                      fa i: 3
                          li: 4,
                                      pi: 0-4,
278
        Vessel i: 20:
                                                              ai-di: 2-9,
                                                                                     taoi-deltai: 2-9,
                                                                                                                   periodi: 7,
                                                                                                                                               taoPi SP-deltaPi SP: 2-5
                                                                                                  dowork: 1845508,
                          periodPi: 3,
                                                              c i: 1845508,
                                                                                                                                                  fa_i: 3
279
        Vessel i: 21:
                                       pi: 24-28,
                                                                ai-di: 40-56,
                                                                                         taoi-deltai: 40-48,
                                                                                                                          periodi: 8,
                                                                                                                                                      taoPi_SP-
                          li: 4.
                                                                               c_i: 2109152,
                                                                                                                      dowork: 2240974,
      deltaPi SP: 40-42,
                                           periodPi: 2,
                                                                                                                                                                   fa_i: 3
280
        Vessel i: 22:
                          li: 6,
                                       pi: 12-18,
                                                                ai-di: 24-35,
                                                                                         taoi-deltai: 24-28,
                                                                                                                         periodi: 4,
                                                                                                                                                      taoPi SP-
      deltaPi SP: 24-25,
                                           periodPi: 1,
                                                                               c i: 1054576,
                                                                                                                     dowork: 1318220,
                                                                                                                                                                   fa i: 5
                                                                                                                                                    taoPi_SP-deltaPi_SP
                                       pi: 9-14,
                                                              ai-di: 14-31,
                                                                                       taoi-deltai: 14-19,
                                                                                                                        periodi: 5,
281
        Vessel i: 23:
                          li: 5.
     : 14-15,
                                                                                                           dowork: 1318220,
                                 periodPi: 1,
                                                                    c_i: 1318220,
                                                                                                                                                         fa_i: 4
                                                                                                                          periodi: 6,
282
        Vessel i: 24:
                          li: 6.
                                      pi: 14-20,
                                                                ai-di: 11-29,
                                                                                          taoi-deltai: 11-17,
                                                                                                                                                       taoPi_SP-
                                                                               c_i: 1581864,
      deltaPi SP: 11-13,
                                           periodPi: 2,
                                                                                                                      dowork: 1581864,
                                                                                                                                                                   fa_i: 5
        Vessel i: 25:
                                                                ai-di: 28-62,
283
                          li: 6.
                                       pi: 12-18.
                                                                                         taoi-deltai: 29-35.
                                                                                                                          periodi: 6.
                                                                                                                                                      taoPi SP-
      deltaPi SP: 29-33,
                                            periodPi: 4,
                                                                                c i: 1581864,
                                                                                                                      dowork: 1581864,
                                                                                                                                                                   fa_i: 5
284
        Vessel i: 26:
                                       pi: 25-29.
                                                                ai-di: 51-80,
                                                                                         taoi-deltai: 51-60,
                                                                                                                         periodi: 9,
                                                                                                                                                      taoPi SP-
     deltaPi_SP: 51-53,
                                            periodPi: 2,
                                                                               c_i: 2372796,
                                                                                                                      dowork: 2504618,
                                                                                                                                                                   fa_i: 3
285
                                                                                                                                                      taoPi_SP-
        Vessel i: 27:
                                       pi: 29-34,
                                                                ai-di: 27-46.
                                                                                         taoi-deltai: 27-32,
                                                                                                                         periodi: 5,
      deltaPi_SP: 27-28,
                                           periodPi: 1,
                                                                                c i: 1318220,
                                                                                                                      dowork: 1318220,
                                                                                                                                                                   fa_i: 4
        Vessel i: 28:
                         li: 6,
                                       pi: 23-29,
                                                                ai-di: 21-45,
                                                                                         taoi-deltai: 21-27,
                                                                                                                          periodi: 6,
                                                                                                                                                      taoPi SP-
      deltaPi SP: 21-23,
                                            periodPi: 2,
                                                                                c i: 1581864.
                                                                                                                      dowork: 1581864.
                                                                                                                                                                   fa_i: 5
                                       pi: 24-28,
                                                                ai-di: 29-55,
                                                                                         taoi-deltai: 34-39,
                                                                                                                                                      taoPi SP-
287
        Vessel i: 29:
                         1i: 4.
                                                                                                                          periodi: 5,
      deltaPi SP: 34-36,
                                            periodPi: 2,
                                                                               c_i: 1318220,
                                                                                                                      dowork: 1450042,
                                                                                                                                                                   fa_i: 3
288
     TimeSolveModel: 1248.000000
289
290
     TimeAll: 1252.000000
291
```

292