```
"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=21885

import sys; print('Python %s on %s' % (sys.version, sys.platform))
sys.path.extend(['E:\\1 □□□□\\3 □□□□□□\\1 □□□□□□□\\1 □□□□□□□□□\\1_□□□□□□_□□□□\\1_LW _□□□□\\4 □□□□\\3 python_code\\9 Code for this paper', 'E:/1 □□□□/3 □□□□□/1 □□□□□□/1 □□□□□□□/1_□□□□□□_□□□□/1_LW _□□□□/4 □□□□/3 python_code/9 Code for this paper'])

PyDev console: starting.

Python 3.9.7 (tags/v3.9.7:1016ef3, Aug 30 2021, 20:19:38) [MSC v.1929 64 bit (AMD64)] on win32
>>> runfile('E:/1 □□□□/3 □□□□□/1 □□□□□□□/1 □□□□□□□□□/1_□□□□□□_□□□□/1_LW _□□□□/4 □□□□/3 python_code/9 Code for this paper/main_DM.py', wdir='E:/1 □□□□/3 □□□□□/1 □□□□□□□/1 □□□□□□□□□/1_□□□□□□_□□□□/1_LW _□□□□/4 □□□□/3 python_code/9 Code for this paper')
Backend TkAgg is interactive backend. Turning interactive mode on.
Waiting 5s.....

Optimize the  ./R_9_1.xlsx  instance

Set parameter TimeLimit to value 1200

Set parameter PoolSolutions to value 3
Set parameter PoolGap to value 0.05
Set parameter PoolSearchMode to value 2
Gurobi Optimizer version 11.0.0 build v11.0.0rc2 (win64 - Windows 10.0 (19045.2))

CPU model: 11th Gen Intel(R) Core(TM) i7-11370H @ 3.30GHz, instruction set [SSE2|AVX|AVX2|AVX512]
Thread count: 4 physical cores, 8 logical processors, using up to 8 threads

Optimize a model with 213639 rows, 72324 columns and 629811 nonzeros
Model fingerprint: 0xe9182ad1
Variable types: 0 continuous, 72324 integer (60921 binary)
Coefficient statistics:
  Matrix range     [1e+00, 5e+05]
  Objective range  [1e+00, 1e+00]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 8e+06]
Presolve removed 166609 rows and 2477 columns
Presolve time: 0.34s
Presolved: 47030 rows, 69847 columns, 138085 nonzeros
Variable types: 0 continuous, 69847 integer (58453 binary)
Root relaxation presolved: 46994 rows, 69883 columns, 138012 nonzeros

Deterministic concurrent LP optimizer: primal and dual simplex
Showing primal log only...

Concurrent spin time: 0.00s

Solved with dual simplex

Root relaxation: objective 4.239313e+02, 3899 iterations, 0.38 seconds (0.61 work units)

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

     0     0  423.93135    0 2897          -  423.93135      -     -    1s
H    0     0                     659.0000000  423.93135  35.7%     -    2s
H    0     0                     658.0000000  423.93135  35.6%     -    3s
     0     0  446.11431    0 2704  658.00000  446.11431  32.2%     -    4s
H    0     0                     656.0000000  446.11563  32.0%     -   14s
     0     0  496.00000    0 2759  656.00000  496.00000  24.4%     -   15s
     0     0  496.03935    0 2733  656.00000  496.03935  24.4%     -   15s
     0     0  496.04700    0 2904  656.00000  496.04700  24.4%     -   15s
     0     0  496.07544    0 2500  656.00000  496.07544  24.4%     -   16s
     0     0  497.00000    0 2561  656.00000  497.00000  24.2%     -   20s
     0     0  497.00000    0 2824  656.00000  497.00000  24.2%     -   20s
     0     0  497.00000    0 2218  656.00000  497.00000  24.2%     -   22s
     0     0  497.00000    0 2317  656.00000  497.00000  24.2%     -   26s
     0     0  497.00000    0 2378  656.00000  497.00000  24.2%     -   26s
     0     0  497.00000    0 2379  656.00000  497.00000  24.2%     -   26s
     0     0  497.00000    0 1836  656.00000  497.00000  24.2%     -   27s
     0     0  497.00000    0 2145  656.00000  497.00000  24.2%     -   30s
     0     0  497.00000    0 2226  656.00000  497.00000  24.2%     -   30s
     0     0  497.00000    0 2388  656.00000  497.00000  24.2%     -   30s
     0     0  497.00000    0 2389  656.00000  497.00000  24.2%     -   30s
     0     0  497.00000    0 2220  656.00000  497.00000  24.2%     -   31s
     0     0  497.00000    0 2107  656.00000  497.00000  24.2%     -   32s
     0     2  497.00000    0 2060  656.00000  497.00000  24.2%     -   38s
   161   170  497.00000   41 1803  656.00000  497.00000  24.2% 24.2   40s
   860   897  497.00000  210 1654  656.00000  497.00000  24.2% 15.8   45s
  1765  1878  548.76110  429 1344  656.00000  497.00000  24.2% 26.0   50s
  2206  2172  552.07774  485 1290  656.00000  497.00000  24.2% 28.4   61s
  2748  2796  575.00000  616 1216  656.00000  497.00000  24.2% 32.3   65s
  3751  3794  611.00725  850  906  656.00000  497.00000  24.2% 31.8   70s
```

80	4114	3972	587.00000	557	2107	656.00000	497.00000	24.2%	35.5	81s
81	4116	3973	622.00000	627	1868	656.00000	622.00000	5.18%	35.5	86s
82	4117	3974	623.00000	765	227	656.00000	623.00000	5.03%	35.4	95s
83	4122	3977	627.38390	514	544	656.00000	627.38390	4.36%	35.4	101s
84	4128	3981	630.27292	58	1066	656.00000	630.27292	3.92%	35.3	106s
85	4130	3983	631.29031	900	1006	656.00000	631.29031	3.77%	35.3	112s
86	4135	3986	633.12852	421	888	656.00000	633.12852	3.49%	35.3	116s
87	4137	3987	633.47749	533	849	656.00000	633.47749	3.43%	35.3	131s
88	4141	3990	634.69933	346	891	656.00000	634.69933	3.25%	35.2	137s
89	4147	3995	637.79821	447	636	656.00000	637.79821	2.77%	50.2	142s
90	4154	4000	639.84957	510	753	656.00000	639.84957	2.46%	50.1	147s
91	4158	4002	639.95499	31	714	656.00000	639.95499	2.45%	50.0	150s
92	4357	4127	643.36691	50	388	656.00000	642.30516	2.09%	66.7	155s
93	4777	4306	644.00000	91	322	656.00000	642.30516	2.09%	82.4	160s
94	5093	4435	644.00000	121	300	656.00000	642.30516	2.09%	94.3	165s
95	5418	4600	645.00000	160	319	656.00000	642.30516	2.09%	106	170s
96	5515	4616	645.00000	173	320	656.00000	642.30516	2.09%	110	177s
97	5574	4692	646.00000	181	288	656.00000	642.30516	2.09%	112	180s
98	5697	4733	646.00000	196	309	656.00000	642.30516	2.09%	115	185s
99	5823	4823	643.00000	43	358	656.00000	642.31387	2.09%	119	190s
100	6113	4958	644.41615	169	359	656.00000	642.31387	2.09%	119	198s
101	6222	5011	646.73684	181	300	656.00000	642.31387	2.09%	121	202s
102	6370	5025	649.00000	223	218	656.00000	642.31387	2.09%	123	206s
103	6472	5058	infeasible	241		656.00000	642.31387	2.09%	126	211s
104	6574	5207	643.00000	60	399	656.00000	642.32408	2.08%	127	216s
105	6757	5360	643.00000	120	420	656.00000	642.32408	2.08%	127	221s
106	7005	5484	644.01121	186	356	656.00000	642.32408	2.08%	126	226s
107	7255	5435	646.28583	210	283	656.00000	642.32408	2.08%	126	232s
108	7364	5558	649.98783	212	209	656.00000	643.00000	1.98%	129	238s
109	7580	5931	645.00000	60	267	656.00000	643.00000	1.98%	130	250s
110	8074	5999	644.00000	45	279	656.00000	643.00000	1.98%	133	263s
111	8351	6340	648.00000	68	190	656.00000	643.00000	1.98%	136	279s
112	8840	6299	648.00000	164	210	656.00000	643.00000	1.98%	138	335s
113	H 8856	6092				655.0000000	643.00000	1.83%	138	335s
114	8992	6450	cutoff	180		655.00000	643.00000	1.83%	139	350s
115	9422	5932	646.60821	209	212	655.00000	643.00000	1.83%	138	363s
116	9978	6136	645.00000	132	279	655.00000	643.00000	1.83%	142	377s
117	10505	5962	652.00000	92	2107	655.00000	643.00000	1.83%	147	383s
118	10508	5964	648.00000	85	530	655.00000	643.00000	1.83%	147	385s
119	10514	5968	643.00000	62	617	655.00000	643.00000	1.83%	147	394s
120	10515	5969	648.00000	153	619	655.00000	643.39998	1.77%	147	395s
121	H10520	5673				653.0000000	643.72529	1.42%	147	415s
122	10642	5698	647.57546	60	265	653.00000	644.48662	1.30%	153	420s
123	10911	5775	644.93732	56	282	653.00000	644.93732	1.23%	162	425s
124	11135	5853	644.93732	86	314	653.00000	644.93732	1.23%	173	430s
125	11443	5967	647.00000	120	208	653.00000	645.08580	1.21%	181	435s
126	11920	6194	cutoff	153		653.00000	645.09312	1.21%	186	440s
127	12322	6478	646.00000	73	289	653.00000	645.93732	1.08%	196	445s
128	13092	6943	646.00000	123	247	653.00000	645.93900	1.08%	205	452s
129	13931	7267	infeasible	113		653.00000	646.00000	1.07%	209	457s
130	14830	7586	653.61673	137	91	653.00000	646.00000	1.07%	213	462s
131	15751	7998	647.00000	123	159	653.00000	646.00000	1.07%	215	467s
132	16260	8191	649.00000	156	161	653.00000	646.00000	1.07%	216	470s
133	17225	8503	648.00000	134	242	653.00000	646.00000	1.07%	221	476s
134	18042	8850	infeasible	102		653.00000	646.00000	1.07%	226	482s
135	18539	9107	cutoff	106		653.00000	646.00000	1.07%	229	485s
136	19653	9476	653.10459	155	129	653.00000	646.00000	1.07%	233	492s
137	20230	9572	648.00000	114	195	653.00000	646.00000	1.07%	236	496s
138	20777	9790	651.45173	161	148	653.00000	646.00000	1.07%	239	500s
139	21881	10094	646.00000	76	189	653.00000	646.00000	1.07%	244	507s
140	22452	10246	cutoff	129		653.00000	646.00000	1.07%	245	510s
141	23367	10650	647.00000	133	219	653.00000	646.00000	1.07%	251	516s
142	23918	10585	infeasible	162		653.00000	646.00000	1.07%	253	522s
143	24087	6723	648.68493	178	145	653.00000	646.00000	1.07%	253	525s
144	24779	6767	cutoff	134		653.00000	646.00000	1.07%	259	532s
145	25158	6701	cutoff	126		653.00000	646.04698	1.06%	262	535s
146	26042	6986	647.00000	68	168	653.00000	646.93732	0.93%	264	543s
147	26636	7231	647.00000	94	139	653.00000	646.96569	0.92%	266	547s
148	27195	7565	649.58326	116	129	653.00000	647.00000	0.92%	270	552s
149	27913	7814	649.00000	128	117	653.00000	647.00000	0.92%	271	556s
150	28528	8107	648.00000	102	165	653.00000	647.00000	0.92%	273	563s
151	29168	8341	cutoff	148		653.00000	647.00000	0.92%	274	572s
152	29814	8563	648.00000	102	150	653.00000	647.00000	0.92%	276	585s
153	30434	8711	648.00000	136	77	653.00000	647.00000	0.92%	278	603s
154	30938	8944	infeasible	120		653.00000	647.00000	0.92%	281	620s
155	31550	8945	651.00000	127	2107	653.00000	647.00000	0.92%	284	635s
156	31557	8951	650.00000	135	422	653.00000	647.00000	0.92%	284	640s
157	31558	8952	648.00000	127	297	653.00000	647.00000	0.92%	284	645s
158	31560	8953	652.00000	87	508	653.00000	647.00000	0.92%	284	655s
159	31562	8955	648.00000	132	538	653.00000	647.00000	0.92%	284	660s
160	31564	8956	648.00000	126	498	653.00000	647.00000	0.92%	284	673s
161	31565	8957	648.00000	98	521	653.00000	647.00000	0.92%	284	675s
162	31567	8958	647.18288	116	354	653.00000	647.00000	0.92%	284	680s
163	31568	8959	647.00000	122	354	653.00000	647.00000	0.92%	284	690s

```
164   31571  8961  648.72949   65  245  653.00000  647.00000  0.92%   284  695s
165   31618  8966  648.89386   76  188  653.00000  647.00000  0.92%   284  700s
166   31692  8965 infeasible   92       653.00000  647.00000  0.92%   285  705s
167   31788  8974  647.77360   95  177  653.00000  647.00000  0.92%   285  710s
168   31849  8988  647.06773   85  239  653.00000  647.00000  0.92%   286  715s
169   31932  9023  649.00000  110  119  653.00000  647.00000  0.92%   286  720s
170   32031  9024  647.00000   73  181  653.00000  647.00000  0.92%   287  725s
171   32163  9048  647.00000  101  176  653.00000  647.00000  0.92%   286  730s
172   32351  9073     cutoff  137       653.00000  647.00000  0.92%   285  736s
173   32463  9074  649.00000   95  132  653.00000  647.00000  0.92%   285  740s
174   32644  9114  650.00000  139  134  653.00000  647.00000  0.92%   284  745s
175   32771  9105  649.01141  112  187  653.00000  647.01192  0.92%   284  750s
176   32918  9109  649.00000   93   99  653.00000  648.00000  0.77%   283  755s
177   33152  9118  650.00000  112  117  653.00000  648.00000  0.77%   283  761s
178   33408  9233     cutoff  122       653.00000  648.00000  0.77%   282  767s
179   33579  9217  649.25480  102  110  653.00000  648.00000  0.77%   282  771s
180   33880  9233  650.83636  115  135  653.00000  648.00000  0.77%   282  776s
181   34936  9278  650.45808  126   76  653.00000  648.00000  0.77%   279  780s
182   36172  9622     cutoff  129       653.00000  649.00000  0.61%   275  786s
183   37178  9768  651.26726   91  113  653.00000  649.00000  0.61%   274  791s
184   38290  9791  650.00000  125   66  653.00000  649.00000  0.61%   271  795s
185   39575  9911 infeasible  115       653.00000  649.00000  0.61%   268  801s
186   41004  9882 infeasible  126       653.00000  649.00000  0.61%   265  806s
187   42438  9645  651.00000  126 2107  653.00000  649.00000  0.61%   263  859s
188   42440  9646  650.00000   93  183  653.00000  649.00000  0.61%   263  860s
189   42448  9653  650.00000  102  271  653.00000  649.00000  0.61%   263  866s
190   42453  9657  649.34908  121  222  653.00000  649.01007  0.61%   263  870s
191   42457  9659  650.00779  117  119  653.00000  650.00779  0.46%   263  875s
192   42464  9664  652.00000  128  155  653.00000  650.13837  0.44%   263  880s
193   42472  9669  652.00000  115  142  653.00000  651.00000  0.31%   263  885s
194
195  Cutting planes:
196    Learned: 52
197    Gomory: 9
198    Lift-and-project: 7
199    Cover: 3
200    Implied bound: 2
201    MIR: 27
202    StrongCG: 2
203    Flow cover: 87
204    Zero half: 7
205    RLT: 11
206    Relax-and-lift: 126
207
208  Explored 42474 nodes (11214635 simplex iterations) in 888.24 seconds (982.99 work units)
209  Thread count was 8 (of 8 available processors)
210
211  Solution count 3: 653 653 653
212  No other solutions better than 653
213
214  Optimal solution found (tolerance 1.00e-04)
215  Best objective 6.530000000000e+02, best bound 6.530000000000e+02, gap 0.0000%
216
217  Output optimal solution and the Optimal Obj:  653.0
218
219
220  Obj = 653.0
221
222  Solutions:
223      The total pi =  127.0
224      The total duration time in berth stage =  196.0
225      The total duration time in quay crane scheduling stage =  45.0
226      The total departure time in berth stage=  402.0
227      The total departure time in quay crane scheduling stage =  251.0
228      The total wasted crane work hour according QC0=  11.053739133073387
229      The last depature time in quay crane scheduling stage =  75.0
230
231  The specific solution are as follows:
232      Vessel i: 0      li: 6,          pi: 28-34,              ai-di: 20-45,              taoi-deltai: 20-45,              periodi: 25,              taoPi_SP-
     deltaPi_SP: 20-28,                  periodPi: 8,                        c_i: 6480487,                  dowork: 6591100,                  fa_i: 4
233      Vessel i: 1      li: 5,          pi: 14-19,              ai-di: 4-12,               taoi-deltai: 4-12,               periodi: 8,               taoPi_SP-deltaPi_SP: 4
     -6,                         periodPi: 2,                        c_i: 2048798,                  dowork: 2109152,                  fa_i: 3
234      Vessel i: 2      li: 7,          pi: 0-7,                ai-di: 20-50,              taoi-deltai: 20-50,              periodi: 30,              taoPi_SP-deltaPi_SP
     : 20-28,                        periodPi: 8,                        c_i: 7761436,                  dowork: 7909320,                  fa_i: 4
235      Vessel i: 3      li: 7,          pi: 21-28,              ai-di: 29-61,              taoi-deltai: 29-61,              periodi: 32,              taoPi_SP-
     deltaPi_SP: 29-35,                  periodPi: 6,                        c_i: 8409158,                  dowork: 9227540,                  fa_i: 4
236      Vessel i: 4      li: 6,          pi: 8-14,               ai-di: 73-82,              taoi-deltai: 73-82,              periodi: 9,               taoPi_SP-deltaPi_SP:
     73-75,                          periodPi: 2,                        c_i: 2118580,                  dowork: 2636440,                  fa_i: 3
237      Vessel i: 5      li: 7,          pi: 14-21,              ai-di: 18-58,              taoi-deltai: 18-47,              periodi: 29,              taoPi_SP-
     deltaPi_SP: 18-23,                  periodPi: 5,                        c_i: 7457742,                  dowork: 7645676,                  fa_i: 4
238      Vessel i: 6      li: 7,          pi: 7-14,               ai-di: 1-41,               taoi-deltai: 1-29,               periodi: 28,              taoPi_SP-deltaPi_SP: 1
     -8,                         periodPi: 7,                        c_i: 7269633,                  dowork: 7909320,                  fa_i: 4
239      Vessel i: 7      li: 7,          pi: 7-14,               ai-di: 39-75,              taoi-deltai: 39-61,              periodi: 22,              taoPi_SP-deltaPi_SP
     : 39-43,                        periodPi: 4,                        c_i: 5588920,                  dowork: 5800168,                  fa_i: 4
```

```
240     Vessel i: 8:      li: 6,          pi: 28-34,          ai-di: 2-29,          taoi-deltai: 2-15,          periodi: 13,          taoPi_SP-deltaPi_SP
        : 2-5,          periodPi: 3,          c_i: 3338904,          dowork: 3559194,          fa_i: 3
241   TimeSolveModel: 897.000000
242
243   TimeAll: 901.000000
244
245
```