```
"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=7245

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_14_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 497014 rows, 114254 columns and 1475026 nonzeros
Model fingerprint: 0x851c4be2
Variable types: 0 continuous, 114254 integer (96516 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, 4e+06]
Presolve removed 407783 rows and 4969 columns
Presolve time: 0.23s
Presolved: 89231 rows, 109285 columns, 267743 nonzeros
Variable types: 0 continuous, 109285 integer (91547 binary)
Root relaxation presolved: 69305 rows, 109362 columns, 204900 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 5.657005e+02, 4769 iterations, 0.60 seconds (0.70 work units)

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

     0     0  565.70047    0 3376          -  565.70047      -     -    2s
H    0     0                1592.0000000  565.70047  64.5%     -    2s
H    0     0                1000.0000000  565.70047  43.4%     -    4s
H    0     0                 999.0000000  565.70047  43.4%     -    5s
     0     0  576.45098    0 3164  999.00000  576.45098  42.3%     -    6s
     0     0  600.28018    0 3386  999.00000  600.28018  39.9%     -   14s
     0     0  602.00000    0 3384  999.00000  602.00000  39.7%     -   15s
     0     0  602.00000    0 3034  999.00000  602.00000  39.7%     -   16s
     0     0  603.00000    0 3328  999.00000  603.00000  39.6%     -   19s
     0     0  603.00000    0 3329  999.00000  603.00000  39.6%     -   19s
     0     0  603.00000    0 2362  999.00000  603.00000  39.6%     -   21s
     0     0  604.00000    0 2855  999.00000  604.00000  39.5%     -   23s
     0     0  604.00000    0 2900  999.00000  604.00000  39.5%     -   23s
     0     0  604.00000    0 2986  999.00000  604.00000  39.5%     -   23s
     0     0  604.00000    0 3058  999.00000  604.00000  39.5%     -   24s
     0     0  604.00000    0 2404  999.00000  604.00000  39.5%     -   25s
     0     0  604.00000    0 2324  999.00000  604.00000  39.5%     -   26s
     0     2  604.00000    0 2250  999.00000  604.00000  39.5%     -   30s
H  110   115                 998.0000000  604.00000  39.5%  47.0   57s
   303   322  613.96154   75 2469  998.00000  604.00000  39.5%  19.2   60s
   759   786  635.09840  187 2378  998.00000  604.00000  39.5%  12.1   65s
  1246  1370  714.60570  297 2262  998.00000  604.00000  39.5%   9.2   70s
  2065  2157  747.34516  518 2045  998.00000  604.00000  39.5%   8.9   75s
  2943  2908  774.75784  601 1607  998.00000  604.00000  39.5%   9.1   80s
  3802  3986  829.65616  915 1479  998.00000  604.00000  39.5%  10.4   86s
  4549  4730  834.70131 1079 1210  998.00000  604.00000  39.5%  11.8   90s
  5309  5169  678.70425  152 34673  998.00000  604.00000  39.5%  13.6  108s
  5311  5170  890.01263  730 1864  998.00000  604.00000  39.5%  13.6  135s
  5313  5172  967.00000  801  163  998.00000  967.00000  3.11%  13.6  140s
```

80	5317	5175	967.07835	25	68	998.00000	967.07835	3.10%	16.9	148s
81	5320	5179	967.07835	929	23974	998.00000	967.07835	3.10%	17.4	153s
82	5322	5180	967.07835	367	63	998.00000	967.07835	3.10%	17.4	158s
83	5325	5184	967.07835	195	23749	998.00000	967.07835	3.10%	18.0	162s
84	5327	5185	967.07835	1000	75	998.00000	967.07835	3.10%	18.0	166s
85	5330	5189	967.07835	781	23559	998.00000	967.07835	3.10%	18.4	170s
86	5332	5190	967.07835	83	58	998.00000	967.07835	3.10%	18.4	178s
87	5333	5191	967.07835	494	96	998.00000	967.07835	3.10%	18.4	183s
88	5336	5194	967.07835	373	22683	998.00000	967.07835	3.10%	19.0	188s
89	5338	5195	967.07835	633	72	998.00000	967.07835	3.10%	19.0	192s
90	5339	5196	967.07835	192	103	998.00000	967.07835	3.10%	19.0	197s
91	5342	5199	967.07835	342	22205	998.00000	967.07835	3.10%	19.6	201s
92	5344	5200	967.07835	215	60	998.00000	967.07835	3.10%	19.6	209s
93	5345	5201	967.07835	82	109	998.00000	967.07835	3.10%	19.6	214s
94	5348	5204	967.07835	791	21823	998.00000	967.07835	3.10%	20.4	218s
95	5350	5205	967.07835	80	66	998.00000	967.07835	3.10%	20.4	222s
96	5351	5206	967.07835	887	110	998.00000	967.07835	3.10%	20.4	228s
97	5354	5209	967.07835	643	21524	998.00000	967.07835	3.10%	21.0	232s
98	5356	5210	967.07835	175	58	998.00000	967.07835	3.10%	21.0	237s
99	5357	5211	967.07835	241	113	998.00000	967.07835	3.10%	21.0	241s
100	H 5357	4950				997.0000000	967.07835	3.00%	21.0	244s
101	5358	4951	967.07835	1035	118	997.00000	967.07835	3.00%	21.0	247s
102	5359	4951	967.61971	689	205	997.00000	967.61971	2.95%	21.0	263s
103	5361	4953	967.61971	500	224	997.00000	967.61971	2.95%	21.0	270s
104	5363	4706	969.39434	282	394	997.00000	969.39434	2.77%	21.0	275s
105	5367	4709	970.43871	933	391	997.00000	970.43871	2.66%	21.0	284s
106	5368	4709	972.22770	399	275	997.00000	972.22770	2.48%	21.0	287s
107	5370	4711	972.41110	731	377	997.00000	972.41110	2.47%	21.0	293s
108	5374	4713	973.10403	443	499	997.00000	973.10403	2.40%	21.0	302s
109	5375	4478	975.44227	944	545	997.00000	975.44227	2.16%	21.0	305s
110	5377	4479	975.77344	1277	612	997.00000	975.77344	2.13%	21.0	310s
111	5381	4482	976.52001	847	634	997.00000	976.52001	2.05%	20.9	321s
112	5386	4485	978.81119	494	594	997.00000	978.81119	1.82%	20.9	325s
113	5389	4487	978.81215	610	599	997.00000	978.81215	1.82%	20.9	330s
114	5399	4494	980.56212	817	552	997.00000	980.56212	1.65%	20.9	335s
115	5405	4498	981.94112	554	628	997.00000	981.94112	1.51%	20.8	341s
116	5417	4506	983.11485	25	570	997.00000	983.11485	1.39%	20.8	345s
117	5428	4513	983.30750	44	563	997.00000	983.30750	1.37%	20.8	351s
118	5438	4520	983.51330	633	575	997.00000	983.51330	1.35%	20.7	356s
119	5445	4525	983.66989	82	534	997.00000	983.66989	1.34%	20.7	360s
120	5449	4527	983.79209	845	527	997.00000	983.79209	1.32%	20.7	365s
121	5460	4535	983.92913	999	535	997.00000	983.92913	1.31%	20.6	371s
122	5469	4541	984.04979	188	508	997.00000	984.04979	1.30%	20.6	375s
123	5480	4548	984.21154	323	509	997.00000	984.21154	1.28%	20.6	380s
124	5488	4553	984.27786	506	503	997.00000	984.27786	1.28%	20.5	385s
125	5495	4558	984.36121	107	556	997.00000	984.36121	1.27%	20.5	390s
126	5504	4564	984.41195	95	482	997.00000	984.41195	1.26%	20.5	395s
127	5513	4570	984.42675	801	536	997.00000	984.42675	1.26%	20.4	400s
128	5524	4577	984.53023	1144	537	997.00000	984.53023	1.25%	20.4	405s
129	5532	4583	984.56420	83	477	997.00000	984.56420	1.25%	20.4	410s
130	5539	4587	984.62348	192	566	997.00000	984.62348	1.24%	20.3	415s
131	5547	4593	984.66742	437	511	997.00000	984.66742	1.24%	20.3	420s
132	5554	4597	984.69793	643	486	997.00000	984.69793	1.23%	20.3	425s
133	5564	4604	984.75727	672	536	997.00000	984.75727	1.23%	20.3	430s
134	5572	4609	984.75727	655	542	997.00000	984.75727	1.23%	20.2	435s
135	5580	4615	984.78655	323	525	997.00000	984.78655	1.23%	20.2	440s
136	5586	4619	984.85737	494	524	997.00000	984.85737	1.22%	20.2	445s
137	5594	4624	984.89508	741	515	997.00000	984.89508	1.21%	20.1	450s
138	5605	4631	984.93832	554	517	997.00000	984.93832	1.21%	20.1	455s
139	5615	4638	985.01614	465	474	997.00000	985.01614	1.20%	20.1	460s
140	5625	4645	985.06502	195	483	997.00000	985.06502	1.20%	20.0	465s
141	5636	4652	985.10403	373	494	997.00000	985.10403	1.19%	20.0	470s
142	5644	4657	985.14265	215	499	997.00000	985.14265	1.19%	20.0	476s
143	5646	4659	985.14340	1101	530	997.00000	985.14340	1.19%	20.0	480s
144	5653	4663	985.18008	1017	450	997.00000	985.18008	1.19%	19.9	487s
145	5654	4664	985.22043	643	444	997.00000	985.22043	1.18%	19.9	490s
146	5660	4668	985.26381	999	442	997.00000	985.26381	1.18%	19.9	502s
147	5663	4670	985.28820	282	414	997.00000	985.28820	1.17%	19.9	505s
148	5669	4674	985.30934	188	452	997.00000	985.30934	1.17%	19.9	512s
149	5671	4675	985.30969	392	464	997.00000	985.30969	1.17%	19.9	519s
150	5672	4676	985.39831	655	460	997.00000	985.39831	1.16%	19.9	521s
151	5677	4679	985.42501	1277	456	997.00000	985.42501	1.16%	19.8	527s
152	5682	4683	985.63869	256	406	997.00000	985.63869	1.14%	19.8	530s
153	5685	4685	985.70437	806	368	997.00000	985.70437	1.13%	19.8	535s
154	5690	4688	985.73009	298	394	997.00000	985.73009	1.13%	19.8	542s
155	5695	4691	985.85215	107	426	997.00000	985.85215	1.12%	19.8	547s
156	5697	4693	985.92250	377	427	997.00000	985.92250	1.11%	19.8	550s
157	5701	4695	985.92502	669	455	997.00000	985.92502	1.11%	19.8	555s
158	5707	4699	987.00462	752	430	997.00000	987.00462	1.00%	19.7	561s
159	5712	4703	988.00000	1110	449	997.00000	988.00000	0.90%	19.7	567s
160	5715	4705	988.00000	465	437	997.00000	988.00000	0.90%	19.7	570s
161	5719	4707	988.00000	358	415	997.00000	988.00000	0.90%	19.7	578s
162	5725	4711	989.00000	195	373	997.00000	989.00000	0.80%	19.7	582s
163	5729	4714	989.00674	974	387	997.00000	989.00674	0.80%	19.7	585s

```
  5731  4715  990.00000  141  392  997.00000  990.00000  0.70%  19.7  590s
  5738  4720  991.00000  633  411  997.00000  991.00000  0.60%  19.6  595s
  5743  4724  991.00000  476   84  997.00000  991.00000  0.60%  44.0  600s
  5747  4727  991.00000  437  230  997.00000  991.00000  0.60%  43.9  605s
  5754  4732  991.00000  643  255  997.00000  991.00000  0.60%  43.9  612s
  5756  4733  991.00000  175  278  997.00000  991.00000  0.60%  43.9  616s
  5759  4735  991.00000  689  209  997.00000  991.00000  0.60%  43.8  621s
  5817  4732 infeasible  142       997.00000  991.00000  0.60%  45.3  625s
  5909  4733  993.00000  156   27  997.00000  991.00000  0.60%  44.8  630s
  6017  4699 infeasible  154       997.00000  991.00000  0.60%  44.2  636s

Cutting planes:
  Learned: 5
  Gomory: 26
  Lift-and-project: 1
  Cover: 8
  Implied bound: 25
  Clique: 11
  MIR: 39
  StrongCG: 4
  Flow cover: 178
  Zero half: 21
  RLT: 3
  Relax-and-lift: 624

Explored 6122 nodes (283146 simplex iterations) in 638.29 seconds (319.95 work units)
Thread count was 8 (of 8 available processors)

Solution count 3: 997 997 997
No other solutions better than 997

Optimal solution found (tolerance 1.00e-04)
Best objective 9.970000000000e+02, best bound 9.970000000000e+02, gap 0.0000%

Output optimal solution and the Optimal Obj:  997.0


Obj = 997.0

Solutions:
    The total pi =  239.0
    The total duration time in berth stage =  127.0
    The total duration time in quay crane scheduling stage =  26.0
    The total departure time in berth stage=  549.0
    The total departure time in quay crane scheduling stage =  448.0
    The total wasted crane work hour according QC0=  8.490085114775987
    The last depature time in quay crane scheduling stage =  56.0

The specific solution are as follows:
    Vessel i: 0     li: 7          pi: 21-28,          ai-di: 55-70,          taoi-deltai: 55-61,          periodi: 6,          taoPi_SP-deltaPi_SP: 55-56,          periodPi: 1,          c_i: 1505643,          dowork: 1581864,          fa_i: 4
    Vessel i: 1     li: 5          pi: 17-22,          ai-di: 2-23,          taoi-deltai: 2-14,          periodi: 12,          taoPi_SP-deltaPi_SP: 2-4,          periodPi: 2,          c_i: 2973618,          dowork: 3163728,          fa_i: 4
    Vessel i: 2     li: 6          pi: 22-28,          ai-di: 8-29,          taoi-deltai: 8-20,          periodi: 12,          taoPi_SP-deltaPi_SP: 8-10,          periodPi: 2,          c_i: 2936429,          dowork: 3163728,          fa_i: 4
    Vessel i: 3     li: 7          pi: 6-13,          ai-di: 11-33,          taoi-deltai: 11-24,          periodi: 13,          taoPi_SP-deltaPi_SP: 11-14,          periodPi: 3,          c_i: 3182410,          dowork: 3427372,          fa_i: 4
    Vessel i: 4     li: 6          pi: 28-34,          ai-di: 17-35,          taoi-deltai: 17-26,          periodi: 9,          taoPi_SP-deltaPi_SP: 17-19,          periodPi: 2,          c_i: 2209546,          dowork: 2240974,          fa_i: 4
    Vessel i: 5     li: 6          pi: 21-27,          ai-di: 23-42,          taoi-deltai: 23-33,          periodi: 10,          taoPi_SP-deltaPi_SP: 23-25,          periodPi: 2,          c_i: 2535577,          dowork: 2636440,          fa_i: 4
    Vessel i: 6     li: 6          pi: 8-14,          ai-di: 27-44,          taoi-deltai: 27-35,          periodi: 8,          taoPi_SP-deltaPi_SP: 27-29,          periodPi: 2,          c_i: 1982104,          dowork: 2109152,          fa_i: 4
    Vessel i: 7     li: 5          pi: 29-34,          ai-di: 29-58,          taoi-deltai: 29-39,          periodi: 10,          taoPi_SP-deltaPi_SP: 29-31,          periodPi: 2,          c_i: 2581574,          dowork: 2636440,          fa_i: 4
    Vessel i: 8     li: 5          pi: 14-19,          ai-di: 30-69,          taoi-deltai: 30-44,          periodi: 14,          taoPi_SP-deltaPi_SP: 30-33,          periodPi: 3,          c_i: 3539325,          dowork: 3822838,          fa_i: 4
    Vessel i: 9     li: 5          pi: 9-14,          ai-di: 37-75,          taoi-deltai: 37-46,          periodi: 9,          taoPi_SP-deltaPi_SP: 37-39,          periodPi: 2,          c_i: 2316876,          dowork: 2372796,          fa_i: 4
    Vessel i: 10     li: 7          pi: 19-26,          ai-di: 38-65,          taoi-deltai: 38-42,          periodi: 4,          taoPi_SP-deltaPi_SP: 38-39,          periodPi: 1,          c_i: 1000784,          dowork: 1186398,          fa_i: 4
    Vessel i: 11     li: 5          pi: 23-28,          ai-di: 46-77,          taoi-deltai: 46-54,          periodi: 8,          taoPi_SP-deltaPi_SP: 46-48,          periodPi: 2,          c_i: 1874122,          dowork: 2109152,          fa_i: 4
    Vessel i: 12     li: 7          pi: 14-21,          ai-di: 49-76,          taoi-deltai: 49-55,          periodi: 6,          taoPi_SP-deltaPi_SP: 49-50,          periodPi: 1,          c_i: 1383135,          dowork: 1581864,          fa_i: 4
    Vessel i: 13     li: 6          pi: 8-14,          ai-di: 50-83,          taoi-deltai: 50-56,          periodi: 6,          taoPi_SP-deltaPi_SP: 50-51,          periodPi: 1,          c_i: 1355107,          dowork: 1581864,          fa_i: 4
TimeSolveModel: 653.000000

TimeAll: 657.000000
```