General 2D Bin Packing Problem - Group 9 - Topic 3

Table of contents

The PDF file of the report and everything else in the project are available here:

https://github.com/htnminh/optimization-project

Introduction to important files and directories in the project

- `files\data_generator.py` : The data generator.

- `files\generated_data` : The folder contains all generated files.

- `files\CP_model.py` : The implementation of CP.

- `files\mip_model.py` : The implementation of MIP.

- `files\heuristic_bestfit_area_numpy.py` : The implementation of heuristic.

Analysis

The data are analyzed in the `files` directory.

> Warning: Some last columns might be hidden in the right side if this file is viewed as a page on Notion. PDF file is highly recommended.

The result table

File path: `files\_ana_data_loaded_df.txt`

```
-----------------------------------------------
ANALYTICAL DATA OF CP_model.py WITH time_limit = 120
-----------------------------------------------
    n_rect  n_car      cost  n_car_used  time_limit  time_running
0        5      3     350.0         1.0         120          0.07
1        6      3     350.0         1.0         120          0.07
74       7      3     250.0         2.0         120         49.32
2        7      4     450.0         1.0         120          0.08
3        8      4     100.0         1.0         120          0.09
4        9      4    1550.0         2.0         120          0.10
5       10      3     900.0         1.0         120          0.11
6       11      5     750.0         1.0         120          0.12
7       12      5     550.0         1.0         120        120.11
8       13      4     450.0         1.0         120          0.24
9       14      5    1550.0         2.0         120          1.41
10      15      6     200.0         1.0         120          0.30
11      16      6    1050.0         2.0         120        120.21
12      17      6    1150.0         2.0         120        120.24
13      18      8     150.0         1.0         120          0.40
14      19      9     900.0         3.0         120        120.27
15      20      9     400.0         1.0         120        120.31
```

	n_rect	n_car	cost	n_car_used	time_limit	time_running
16	21	8	950.0	2.0	120	120.32
17	22	8	350.0	1.0	120	0.53
18	23	8	750.0	1.0	120	0.52
19	24	9	100.0	1.0	120	0.54
20	25	10	400.0	1.0	120	0.59
21	26	10	500.0	2.0	120	120.37
22	27	10	350.0	1.0	120	0.86
23	28	9	600.0	2.0	120	120.43
24	29	11	150.0	1.0	120	0.85
25	30	11	900.0	3.0	120	120.50
26	31	10	550.0	1.0	120	6.16
27	32	12	1200.0	2.0	120	120.61
28	33	14	350.0	2.0	120	120.62
29	34	12	750.0	2.0	120	120.64
30	35	11	1550.0	3.0	120	120.64
31	36	12	1200.0	4.0	120	120.71
32	37	12	750.0	3.0	120	120.71
33	38	12	1050.0	3.0	120	120.74
34	39	16	2850.0	5.0	120	120.81
35	40	14	1250.0	3.0	120	120.84
36	41	15	600.0	1.0	120	11.59
37	42	14	700.0	4.0	120	120.96
38	43	17	1050.0	3.0	120	121.05
39	44	18	400.0	2.0	120	121.13
40	45	17	950.0	3.0	120	121.01
41	46	17	1150.0	4.0	120	121.04
42	47	16	650.0	4.0	120	121.08
43	48	18	1000.0	3.0	120	121.13
44	49	15	600.0	3.0	120	121.18
45	50	18	1750.0	5.0	120	121.22
46	51	18	1750.0	3.0	120	121.23
47	52	17	1500.0	3.0	120	121.26
48	53	20	650.0	2.0	120	121.39
49	54	18	2350.0	5.0	120	121.35
50	60	23	2100.0	5.0	120	121.67
51	90	29	1050.0	6.0	120	123.27
52	120	44	3050.0	8.0	120	125.76
53	150	53	4700.0	12.0	120	128.73
54	180	64	3100.0	10.0	120	132.62
55	210	72	7850.0	20.0	120	137.80
56	240	81	6400.0	12.0	120	142.27
57	270	93	9600.0	17.0	120	147.97
58	300	110	35650.0	60.0	120	155.31
59	330	110	32700.0	64.0	120	161.76
60	350	122	36450.0	65.0	120	167.71
61	400	135	NaN	NaN	120	187.90
62	450	158	NaN	NaN	120	204.39
63	500	167	NaN	NaN	120	222.52
64	550	196	NaN	NaN	120	234.08
65	600	200	NaN	NaN	120	252.43
66	650	231	NaN	NaN	120	289.77
67	700	239	NaN	NaN	120	321.15
68	750	250	NaN	NaN	120	351.54
69	800	270	NaN	NaN	120	379.11
70	850	299	NaN	NaN	120	650.40
71	900	318	NaN	NaN	120	608.22
72	950	335	NaN	NaN	120	472.50
73	1000	346	NaN	NaN	120	660.40

```
-------------------------------------------------
ANALYTICAL DATA OF mip_model.py WITH time_limit = 300
-------------------------------------------------
```

	n_rect	n_car	cost	n_car_used	time_limit	time_running
0	5	3	350.0	1.0	300	0.07
1	6	3	350.0	1.0	300	0.08
74	7	3	250.0	2.0	300	2.61
2	7	4	450.0	1.0	300	0.09
3	8	4	100.0	1.0	300	0.12
4	9	4	1550.0	2.0	300	3.23
5	10	3	900.0	1.0	300	0.63
6	11	5	750.0	1.0	300	0.17
7	12	5	550.0	1.0	300	300.16
8	13	4	450.0	1.0	300	0.66
9	14	5	1850.0	3.0	300	300.15
10	15	6	200.0	1.0	300	3.44
11	16	6	1050.0	2.0	300	300.17
12	17	6	1300.0	2.0	300	300.16
13	18	8	150.0	1.0	300	9.31
14	19	9	900.0	3.0	300	300.19
15	20	9	400.0	1.0	300	300.18
16	21	8	950.0	2.0	300	300.19

17	22	8	350.0	1.0	300	42.61
18	23	8	750.0	1.0	300	77.97
19	24	9	100.0	1.0	300	130.52
20	25	10	1000.0	2.0	300	300.27
21	26	10	950.0	3.0	300	300.28
22	27	10	3350.0	5.0	300	300.31
23	28	9	3350.0	5.0	300	300.31
24	29	11	150.0	1.0	300	262.91
25	30	11	1450.0	3.0	300	300.35
26	31	10	2400.0	5.0	300	300.35
27	32	12	4550.0	8.0	300	300.40
28	33	14	7550.0	14.0	300	300.42
29	34	12	5100.0	11.0	300	300.41
30	35	11	4500.0	7.0	300	300.43
31	36	12	5650.0	11.0	300	300.42
32	37	12	3850.0	8.0	300	300.47
33	38	12	4600.0	9.0	300	300.60
34	39	16	9800.0	15.0	300	300.73
35	40	14	8000.0	13.0	300	300.52
36	41	15	NaN	NaN	300	300.68
37	42	14	NaN	NaN	300	301.05
38	43	17	5000.0	10.0	300	300.61
39	44	18	3150.0	6.0	300	300.68
40	45	17	NaN	NaN	300	300.64
41	46	17	NaN	NaN	300	300.70
42	47	16	7400.0	16.0	300	300.68
43	48	18	NaN	NaN	300	300.81
44	49	15	NaN	NaN	300	302.51
45	50	18	NaN	NaN	300	302.53
46	51	18	NaN	NaN	300	303.15
47	52	17	NaN	NaN	300	301.16
48	53	20	12300.0	20.0	300	301.11
49	54	18	NaN	NaN	300	NaN
50	60	23	NaN	NaN	300	NaN
51	90	29	NaN	NaN	300	NaN
52	120	44	NaN	NaN	300	NaN
53	150	53	NaN	NaN	300	NaN
54	180	64	NaN	NaN	300	NaN
55	210	72	NaN	NaN	300	NaN
56	240	81	NaN	NaN	300	NaN
57	270	93	NaN	NaN	300	NaN
58	300	110	NaN	NaN	300	NaN
59	330	110	NaN	NaN	300	NaN
60	350	122	NaN	NaN	300	NaN
61	400	135	NaN	NaN	300	NaN
62	450	158	NaN	NaN	300	NaN
63	500	167	NaN	NaN	300	NaN
64	550	196	NaN	NaN	300	NaN
65	600	200	NaN	NaN	300	NaN
66	650	231	NaN	NaN	300	NaN
67	700	239	NaN	NaN	300	NaN
68	750	250	NaN	NaN	300	NaN
69	800	270	NaN	NaN	300	NaN
70	850	299	NaN	NaN	300	NaN
71	900	318	NaN	NaN	300	NaN
72	950	335	NaN	NaN	300	NaN
73	1000	346	NaN	NaN	300	NaN

```
--------------------------------------------------
ANALYTICAL DATA OF heuristic_bestfit_area_numpy.py WITH GLOBAL_TIME_LIMIT_PER_ITER = 1
--------------------------------------------------
```

	rect_count	car_count	total cost	cars used count	running time	GLOBAL_TIME_LIMIT_PER_ITER	time_exceeded_count
0	5	3	950	1	0.000997	1	0
1	6	3	350	1	0.002014	1	0
74	7	3	300	2	0.000972	1	0
2	7	4	450	1	0.002973	1	0
3	8	4	100	1	0.008007	1	0
4	9	4	1550	2	0.002997	1	0
5	10	3	1000	1	0.006947	1	0
6	11	5	750	1	0.012967	1	0
7	12	5	700	2	0.010993	1	0
8	13	4	450	1	0.020943	1	0
9	14	5	1550	2	0.016961	1	0
10	15	6	250	1	0.036895	1	0
11	16	6	1050	2	0.013963	1	0
12	17	6	1300	2	0.031914	1	0
13	18	8	150	1	0.076802	1	0
14	19	9	1650	3	0.008952	1	0
15	20	9	400	1	0.099759	1	0
16	21	8	950	2	0.033909	1	0
17	22	8	350	1	0.160574	1	0

18	23	8	750	1	0.150594		1	0
19	24	9	100	1	0.223403		1	0
20	25	10	400	1	0.259306		1	0
21	26	10	800	2	0.047872		1	0
22	27	10	350	1	0.292190		1	0
23	28	9	700	1	0.347101		1	0
24	29	11	150	1	0.316155		1	0
25	30	11	900	3	0.026928		1	0
26	31	10	550	1	0.444810		1	0
27	32	12	1200	2	0.186501		1	0
28	33	14	350	2	0.087766		1	0
29	34	12	750	2	0.265292		1	0
30	35	11	1600	3	0.059838		1	0
31	36	12	1200	4	0.032917		1	0
32	37	12	900	3	0.081748		1	0
33	38	12	1050	3	0.134670		1	0
34	39	16	3200	5	0.038895		1	0
35	40	14	1250	3	0.123669		1	0
36	41	15	600	1	0.872666		1	0
37	42	14	700	4	0.085772		1	0
38	43	17	1100	3	0.099733		1	0
39	44	18	1000	2	0.864688		1	0
40	45	17	950	3	0.104718		1	0
41	46	17	1150	4	0.147573		1	0
42	47	16	700	3	0.150597		1	0
43	48	18	1250	3	0.411929		1	0
44	49	15	600	3	0.190490		1	0
45	50	18	1750	5	0.060837		1	0
46	51	18	2000	5	0.152592		1	0
47	52	17	1750	4	0.181485		1	0
48	53	20	950	2	1.098094		1	0
49	54	18	2600	5	0.098738		1	0
50	60	23	2550	6	0.188493		1	0
51	90	29	1150	5	0.560502		1	0
52	120	44	2300	7	0.688131		1	0
53	150	53	3700	12	0.442843		1	0
54	180	64	1700	7	2.248959		1	0
55	210	72	4200	15	2.006664		1	0
56	240	81	3450	8	9.161504		1	0
57	270	93	6050	17	1.640614		1	0
58	300	110	4450	13	3.803832		1	0
59	330	110	4000	16	3.068793		1	0
60	350	122	3150	12	6.357003		1	0
61	400	135	5950	22	2.096394		1	0
62	450	158	6150	21	5.346707		1	0
63	500	167	8400	35	1.706438		1	0
64	550	196	6850	27	3.502637		1	0
65	600	200	8250	29	7.192769		1	0
66	650	231	7150	28	20.260799		1	0
67	700	239	8800	34	7.254632		1	0
68	750	250	13350	42	5.701724		1	0
69	800	270	9650	42	6.406899		1	0
70	850	299	9200	38	9.951397		1	0
71	900	318	13250	41	12.916435		1	0
72	950	335	16550	59	4.232715		1	0
73	1000	346	11800	48	10.196733		1	0

Data analysis

A part of the file `files\_ana_data_loaded_describe.txt`

```
------------------------------------------------------------------------------------------------------------
                                ANALYTICAL DATA OF CP_model.py WITH time_limit = 120
------------------------------------------------------------------------------------------------------------
            n_rect        n_car          cost  n_car_used  time_limit  time_running
count    75.000000    75.000000     62.000000   62.000000        75.0     75.000000
mean    171.760000    59.853333   2990.322581    6.306452       120.0    135.964533
std     266.188352    91.969545   7474.228063   13.413461         0.0    139.483199
min       5.000000     3.000000    100.000000    1.000000       120.0      0.070000
25%      22.500000     9.000000    462.500000    1.000000       120.0     30.455000
50%      41.000000    15.000000    900.000000    2.000000       120.0    120.840000
75%     195.000000    68.000000   1550.000000    4.000000       120.0    135.210000
max    1000.000000   346.000000  36450.000000   65.000000       120.0    660.400000
------------------------------------------------------------------------------------------------------------
                        ANALYTICAL DATA (DROPPED N/A) OF CP_model.py WITH time_limit = 120
------------------------------------------------------------------------------------------------------------
            n_rect        n_car          cost  n_car_used  time_limit  time_running
```

```
count   62.000000  62.000000      62.000000   62.000000        62.0   62.000000
mean    61.000000  21.693548    2990.322581    6.306452       120.0   86.498871
std     81.005161  27.929413    7474.228063   13.413461         0.0   58.735972
min      5.000000   3.000000     100.000000    1.000000       120.0    0.070000
25%     19.250000   8.000000     462.500000    1.000000       120.0    0.997500
50%     34.500000  12.000000     900.000000    2.000000       120.0  120.630000
75%     49.750000  18.000000    1550.000000    4.000000       120.0  121.210000
max    350.000000 122.000000   36450.000000   65.000000       120.0  167.710000
-----------------------------------------------------------------------------------------------------------
                    ANALYTICAL DATA OF mip_model.py WITH time_limit = 300
-----------------------------------------------------------------------------------------------------------
            n_rect        n_car          cost  n_car_used  time_limit  time_running
count    75.000000    75.000000     41.000000   41.000000        75.0     50.000000
mean    171.760000    59.853333   2629.268293    4.926829       300.0    221.164000
std     266.188352    91.969545   2980.456668    5.091121         0.0    128.792955
min       5.000000     3.000000    100.000000    1.000000       300.0      0.070000
25%      22.500000     9.000000    450.000000    1.000000       300.0     91.107500
50%      41.000000    15.000000   1050.000000    2.000000       300.0    300.310000
75%     195.000000    68.000000   4500.000000    8.000000       300.0    300.632500
max    1000.000000   346.000000  12300.000000   20.000000       300.0    303.150000
-----------------------------------------------------------------------------------------------------------
              ANALYTICAL DATA (DROPPED N/A) OF mip_model.py WITH time_limit = 300
-----------------------------------------------------------------------------------------------------------
           n_rect      n_car          cost  n_car_used  time_limit  time_running
count   41.000000  41.000000     41.000000   41.000000        41.0     41.000000
mean    24.487805   9.195122   2629.268293    4.926829       300.0    203.535854
std     12.625613   4.462172   2980.456668    5.091121         0.0    136.198725
min      5.000000   3.000000    100.000000    1.000000       300.0      0.070000
25%     14.000000   5.000000    450.000000    1.000000       300.0      9.310000
50%     24.000000   9.000000   1050.000000    2.000000       300.0    300.190000
75%     34.000000  12.000000   4500.000000    8.000000       300.0    300.420000
max     53.000000  20.000000  12300.000000   20.000000       300.0    301.110000
-----------------------------------------------------------------------------------------------------------
          ANALYTICAL DATA OF heuristic_bestfit_area_numpy.py WITH GLOBAL_TIME_LIMIT_PER_ITER = 1
-----------------------------------------------------------------------------------------------------------
         rect_count   car_count   total cost  cars used count  running time  GLOBAL_TIME_LIMIT_PER_ITER  time_exceeded_count
count     75.000000   75.000000    75.000000        75.000000     75.000000                        75.0                 75.0
mean     171.760000   59.853333  2794.666667         9.306667      1.801636                         1.0                  0.0
std      266.188352   91.969545  3585.712765        13.449579      3.575140                         0.0                  0.0
min        5.000000    3.000000   100.000000         1.000000      0.000972                         1.0                  0.0
25%       22.500000    9.000000   700.000000         1.500000      0.043383                         1.0                  0.0
50%       41.000000   15.000000  1150.000000         3.000000      0.181485                         1.0                  0.0
75%      195.000000   68.000000  3325.000000        10.000000      1.673526                         1.0                  0.0
max     1000.000000  346.000000 16550.000000        59.000000     20.260799                         1.0                  0.0
```

List of tasks

Hoàng Trần Nhật Minh

- Leader (100%)

- Data analysis (5%)

- Heuristic (100%)

- Report (100%)

- Slide (70%)

Nguyễn Hoàng Phúc

- Data analysis (95%)

Nguyễn Hải Long

- MIP model (100%)

- Slide (15%)

Nguyễn Ngọc Dũng

- CP model (100%)

- Slide (15%)