

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

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[Hoàng Trần Nhật Minh](#)

[Nguyễn Hoàng Phúc](#)

[Nguyễn Hải Long](#)

[Nguyễn Ngọc Dũng](#)

The PDF file of the report and everything else in the project is 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
```

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

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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

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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

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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%)