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

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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

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| 5 10 3 900.0 1.0 300 0.63 6 11 5 750.0 1.0 300 9.17 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 1.0 300 304.17 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 | | | | | | | | |
| 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 1.0 300 304.17 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 | | | | | | | | |
| 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 | | | | | | | | |
| 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 | | | | | | | | |
| 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 | | | | | | | | |
| 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 | | | 5 | | | | | |
| 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 | | | | | | | | |
| 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 | | | | | | | | |
| 14 19 9 900.0 3.0 300 300.19 15 20 9 400.0 1.0 300 300.18 | | | | | | | | |
| 15 20 9 400.0 1.0 300 300.18 | | | | | | | | |
| | | | | | | | | |
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```
8 350.0
                                                  42.61
18
      23
                  750.0
                              1.0
                                        300
             8
                            1.0
19
             9
                  100.0
                                        300
                                                  130.52
                                        300
20
      25
             10
                 1000.0
                              2.0
                                                  300.27
21
      26
            10
                 950.0
                             3.0
                                        300
                                                  300.28
22
      27
            10
                 3350.0
                                        300
                                                  300.31
                              5.0
                                        300
23
      28
             9
                 3350.0
                             5.0
                                                  300.31
                                        300
24
      29
            11
                 150.0
                             1.0
                                                  262.91
25
      30
            11
                 1450.0
                             3.0
                                        300
                                                  300.35
           10
26
      31
                 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
           11
                 4500.0
                             7.0
31
            12
                 5650.0
                             11.0
32
      37
            12
                 3850.0
                             8.0
                                        300
                                                  300.47
            12
                 4600.0
                                        300
                                                  300.60
33
      38
                              9.0
                 9800.0
                                        300
                                                  300.73
34
      39
            16
                             15.0
35
      40
            14
                 8000.0
                             13.0
                                        300
                                                  300.52
                                        300
                                                  300.68
36
      41
            15
                 NaN
                             NaN
                                        300
37
      42
            14
                   NaN
                              NaN
                                                  301.05
            17 5000.0
38
      43
                             10.0
                                        300
                                                  300.61
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      44
            18 3150.0
                              6.0
                                        300
                                                  300.68
40
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            17
                 NaN
                              NaN
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                                                  300.64
41
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                                        300
                                                  300.70
42
      47
                 7400.0
                             16.0
                                        300
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43
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                                        300
                                                  300.81
           18
44
      49
            15
                    NaN
                              NaN
                                        300
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                                        300
                                                  302.53
            18
                                        300
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      51
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                                                  303.15
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                                        300
                                                  301.16
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      53
            20 12300.0
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                                        300
                                                  301.11
49
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            18
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     120
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55
      210
             72
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57
      270
             93
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58
      300
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59
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60
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                                        300
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                              NaN
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61
            135
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62
     450
            158
                                        300
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                                        300
63
            167
                    NaN
                              NaN
                                                     NaN
64
      550
            196
                    NaN
                              NaN
                                        300
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65
      600
            200
                    NaN
                              NaN
                                        300
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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
                                        300
                    NaN
70
      850
            299
                              NaN
                                        300
                    NaN
                                                     NaN
71
      900
            318
                    NaN
                              NaN
                                        300
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
           6
                    3
                             350
                                             1
                                                    0.002014
                                                                                  1
                                                                                                     0
                  3 300
4 450
4 100
4 1550
3 1000
74
                                                    0.000972
2
                                                    0.002973
3
                                                   0.008007
          9
                                                    0.002997
          10
                                            1
5
                                                    0.006947
6
          11
                    5
                             750
                                             1
                                                    0.012967
          12
                   5
                            700
7
                                             2
                                                    0.010993
          13
14
8
                    4
                            450
                                             1
                                                    0.020943
                                                                                  1
                                                                                                     0
                   5
                          1550
9
                                             2
                                                    0.016961
                   6
          15
                            250
10
                                             1
                                                    0.036895
                                                                                  1
                          1050
11
          16
                   6
                                             2
                                                    0.013963
                                                                                                     0
                   6
                          1300
12
          17
                                             2
                                                    0.031914
                                                                                  1
                                                                                                     0
13
          18
                    8
                            150
                                             1
                                                    0.076802
                                                                                  1
                                                                                                     0
                   9
14
          19
                            1650
                                             3
                                                    0.008952
                                                                                                     0
```

0.099759

0.033909 0.160574

| 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 | |
| 33 | 38 | 12 | 1050 | 3 | 0.134670 | 1 | |
| 34 | 39 | 16 | 3200 | 5 | 0.038895 | 1 | |
| 35 | 40 | 14 | 1250 | 3 | 0.123669 | 1 | |
| 36 | 41 | 15 | 600 | 1 | 0.872666 | 1 | |
| 37 | 42 | 14 | 700 | 4 | 0.085772 | 1 | |
| 38 | 43 | 17 | 1100 | 3 | 0.099733 | 1 | |
| 39 | 44 | 18 | 1000 | 2 | 0.864688 | 1 | |
| 40 | 45 | 17 | 950 | 3 | 0.104718 | 1 | |
| | | | | | | 1 | |
| 41 | 46 | 17 | 1150 | 4 | 0.147573 | | |
| 42 | 47 | 16 | 700 | 3 | 0.150597 | 1 | |
| 43 | 48 | 18 | 1250 | 3 | 0.411929 | 1 | |
| 44 | 49 | 15 | 600 | 3 | 0.190490 | 1 | |
| 45 | 50 | 18 | 1750 | 5 | 0.060837 | 1 | |
| 46 | 51 | 18 | 2000 | 5 | 0.152592 | 1 | |
| 47 | 52 | 17 | 1750 | 4 | 0.181485 | 1 | |
| 48 | 53 | 20 | 950 | 2 | 1.098094 | 1 | |
| 49 | 54 | 18 | 2600 | 5 | 0.098738 | 1 | |
| 50 | 60 | 23 | 2550 | 6 | 0.188493 | 1 | |
| 51 | 90 | 29 | 1150 | 5 | 0.560502 | 1 | |
| 52 | 120 | 44 | 2300 | 7 | 0.688131 | 1 | |
| 53 | 150 | 53 | 3700 | 12 | 0.442843 | 1 | |
| 54 | 180 | 64 | 1700 | 7 | 2.248959 | 1 | |
| 55 | 210 | 72 | 4200 | 15 | 2.006664 | 1 | |
| 56 | 240 | 81 | 3450 | 8 | 9.161504 | 1 | |
| 57 | 270 | 93 | 6050 | 17 | 1.640614 | 1 | |
| 58 | 300 | 110 | 4450 | 13 | 3.803832 | 1 | |
| 59 | 330 | 110 | 4000 | 16 | 3.068793 | 1 | |
| 60 | 350 | 122 | 3150 | 12 | 6.357003 | 1 | |
| 61 | 400 | 135 | 5950 | 22 | 2.096394 | 1 | |
| 62 | 450 | 158 | 6150 | 21 | 5.346707 | 1 | |
| 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 | |
| 73 | 1000 | 346 | 11800 | 48 | 10.196733 | 1 | |
| | | | | | | | |
| | | | | | | | |

Data analysis

A part of the file files_ana_data_loaded_describe.txt

| 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 | | |
| | | | ANALYTICA | AL DATA OF mi | o_model.py WI | TH time_limit | = 300 | |
| | n_rect | n_ca | r cost | n car used | time limit | time_running | | |
| count | 75.000000 | | | | 75.0 | 50.000000 | | |
| mean | 171.760000 | | | | 300.0 | 221.164000 | | |
| std | 266.188352 | | | | 0.0 | 128.792955 | | |
| min | 5.000000 | | | | 300.0 | 0.070000 | | |
| 25% | 22.500000 | | | | 300.0 | 91.107500 | | |
| 50% | 41.000000 | | | | 300.0 | 300.310000 | | |
| 75% | 195.000000 | | | | 300.0 | 300.632500 | | |
| max | 1000.000000 | | | | 300.0 | 303.150000 | | |
| IIIUX | 1000.000000 | 340.00000 | 0 12300.000000 | 20.000000 | 300.0 | 303.130000 | | |
| count | n_rect | n_car | | | | me_running | | |
| | | 41.000000 | 41.000000 | 41.000000 | 41.0 | 41.000000 | | |
| mean | 24.487805 12.625613 | 9.195122 | 2629.268293 | 4.926829 | 300.0 0.0 | 203.535854 | | |
| std | | 4.462172 | 2980.456668 | 5.091121 | | 136.198725 | | |
| min | 5.000000 | 3.000000 | 100.000000 | 1.000000 | 300.0 | 0.070000 | | |
| 25% | 14.000000 | 5.000000 | 450.000000 | 1.000000 2.000000 | 300.0 | 9.310000 | | |
| 50% | 24.000000 | 9.000000 | 1050.000000 | 2.000000 | | 000 400000 | | |
| 750/ | | 40 000000 | 4500 000000 | | 300.0 | 300.190000 | | |
| 75% | | 12.000000 | 4500.000000 | 8.000000 | 300.0 | 300.420000 | | |
| 75% max | | | 4500.000000 12300.000000 | | | | | |
| | | 20.000000 | 12300.000000 | 8.000000 20.000000 | 300.0 300.0 | 300.420000 301.110000 | TIME_LIMIT_PER_ITER = | 1 |
| | 53.000000 | 20.000000 ANALYTICAL | 12300.000000 DATA OF heuris | 8.000000 20.000000 stic_bestfit_a | 300.0 300.0 area_numpy.py | 300.420000 301.110000 | | |
| max | 53.000000 rect_count | 20.000000 ANALYTICAL car_coun | 12300.000000 DATA OF heuris t t total cost | 8.000000 20.000000 stic_bestfit_a | 300.0 300.0 area_numpy.py | 300.420000 301.110000 / WITH GLOBAL_T | L_TIME_LIMIT_PER_ITER | time_exceeded_count |
| max count | 53.000000 | 20.000000 ANALYTICAL car_coun 75.00000 | DATA OF heuris t total cost 0 75.000000 | 8.000000 20.000000 stic_bestfit_a cars used (| 300.0 300.0 area_numpy.py | 300.420000 301.110000 / WITH GLOBAL_T | TIME_LIMIT_PER_ITER 75.0 | time_exceeded_count |
| max count mean | 53.000000 rect_count 75.000000 171.760000 | 20.000000 ANALYTICAL car_coun 75.00000 59.85333 | 12300.000000 DATA OF heuris t total cost 0 75.000000 3 2794.66666 | 8.000000 20.000000 stic_bestfit_a c cars used (| 300.0 300.0 area_numpy.py count runnir 90000 75. | 300.420000 301.110000 / WITH GLOBAL_ ing time GLOBAL 000000 801636 | L_TIME_LIMIT_PER_ITER 75.0 1.0 | time_exceeded_count 75.0 |
| max count mean std | 75.000000 rect_count 75.000000 171.760000 266.188352 | 20.000000 ANALYTICAL car_coun 75.00000 59.85333 91.96954 | 12300.000000 DATA OF heuris t total cost 0 75.000000 3 2794.666667 5 3585.712768 | 8.000000 20.000000 stic_bestfit_a c cars used (7.5.00 9.30 13.44 | 300.0 300.0 area_numpy.py | 300.420000 301.110000 WITH GLOBAL_ og time GLOBAL 000000 801636 575140 | TIME_LIMIT_PER_ITER 75.0 1.0 0.0 | time_exceeded_count 75.0 0.0 |
| max count mean std min | 75.000000 171.760000 266.188352 5.000000 | 20.000000 ANALYTICAL car_coun 75.00000 59.85333 91.96954 0 3.00000 | DATA OF heuris t total cost 0 75.000000 3 2794.66666 5 3585.712768 0 100.000000 | 8.000000 20.000000 stic_bestfit_a c cars used (75.00 9.30 5.13.44 0.1.00 | 300.0 300.0 area_numpy.py | 300.420000 301.110000 WITH GLOBAL_1 og time GLOBAL 000000 801636 575140 000972 | TIME_LIMIT_PER_ITER 75.0 1.0 0.0 1.0 | time_exceeded_count 75.0 0.0 0.0 |
| max count mean std min 25% | 53.000000 rect_count 75.000000 171.760000 266.188352 5.000000 22.500000 | 20.000000 | DATA OF heuris t total cost 75.00000 2794.66666 5 3585.71276 0 100.000000 0 700.000000 | 8.000000 20.000000 stic_bestfit_a c cars used () 75.00 7 9.30 6 13.44 0 1.00 0 1.50 | 300.0 300.0 area_numpy.py count runnir 20000 75. 206667 1. 49579 3. 20000 0. | 300.420000 301.110000 WITH GLOBAL_T og time GLOBAL 000000 801636 575140 000972 043383 | TIME_LIMIT_PER_ITER 75.0 1.0 0.0 1.0 1.0 | time_exceeded_count 75.0 0.0 0.0 |
| max count mean std min 25% 50% | 75.000000 171.760000 266.188352 5.00000 22.500000 41.000000 | 20.000000 ANALYTICAL Car_coun 75.00000 59.85333 91.96954 3.00000 9.00000 15.00000 | DATA OF heuris t total cost 0 75.00000 3 2794.66666 5 3585.71276 0 100.00000 0 700.00000 0 1150.00000 | 8.000000 20.000000 stic_bestfit_a c cars used 7.000000 7.0000000000 7.00000000000000 | 300.0 300.0 area_numpy.py count runnir 200000 75. 206667 1. 49579 3. 200000 0. | 300.420000 301.110000 WITH GLOBAL_T og time GLOBAL 000000 801636 575140 000972 043383 181485 | L_TIME_LIMIT_PER_ITER 75.0 1.0 0.0 1.0 1.0 1.0 | time_exceeded_count 75.0 0.0 0.0 0.0 0.0 |
| max count mean std min 25% | 53.000000 rect_count 75.000000 171.760000 266.188352 5.000000 22.500000 | 20.000000 ANALYTICAL car_coun 75.00000 59.85333 91.96954 3.00000 9.00000 15.00000 68.00000 | DATA OF heuris t total cost 75.00000 3 2794.66666 5 3585.71276 0 100.00000 0 700.00000 0 1150.00000 0 3325.000000 | 8.000000 20.000000 stic_bestfit_a c cars used (75.00 79.30 13.44 1.00 1.55 1.00 1.50 1.00 1.00 1.00 1.00 | 300.0 300.0 area_numpy.py count runnir 20000 75. 206667 1. 49579 3. 200000 0. 200000 0. | 300.420000 301.110000 WITH GLOBAL_T og time GLOBAL 000000 801636 575140 000972 043383 | TIME_LIMIT_PER_ITER 75.0 1.0 0.0 1.0 1.0 | time_exceeded_count 75.0 0.0 0.0 0.0 0.0 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%)