Test Data for a 2D Rectangular Packing Problem

1. Background

The following instances of a 2D rectangular packing problem have been used in the paper entitled "An Empirical Investigation of Meta-heuristic and Heuristic Algorithms for a 2D Packing Problem" that has been accepted for publication by the European Journal of Operations Research in June 99.

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Abstract

In this paper we consider the two-dimensional rectangular packing problem, where a fixed set of items have to be allocated on a single object. Two heuristics, which belong to the class of packing procedures that preserve bottom-left stability, are hybridised with three meta-heuristic algorithms (genetic algorithms, simulated annealing, naïve evolution) and local search heuristic (hill-climbing). This study compares the hybrid algorithms in terms of solution quality and computation time on a number of packing problems of different size. In order to show the effectiveness of the design of the different algorithms their performance is compared to random search and heuristic packing routines.

2. Description the test problems

The test problems used in the paper have been constructed for a 2D packing problem with the following characteristics:

a set of items, which may contain identical items
one single object of fixed width and infinite height
all pieces are of rectangular shape
items can be rotated by 90°
non-guillotineable

The packing tasks are classified by the problem size, i.e. the number of items. For each category three problems instances have been constructed. The dimensions of the items are given below. The problem instances have been constructed such that at least one optimum solution for each problem is known.

Seven categories of problems have been constructed ranging from 16 to 197 items. Three instances have been generated for each problem category. The problems have been constructed such that the optimal solution is known (see Table 1). Concerning the optimum solution some of the layouts are guillotineable and some are non-guillotineable.

Table 1: Test problems

Problem category	number of items	optimal height	object dimensions
C1	16 or 17	20	20x20
C2	25	15	40x15
C3	28 or 29	30	60x30
C4	49	60	60x60
C5	73	90	60x90
C6	97	120	80x120
C7	196 or 197	240	160x240

3. Data of the test problems

The first column indicates the height of the rectangle, the second one its width.

Category 1:

16 or 17 items; optimum object: 20 x 20

Problem 1:

Number of rectangles: 16

2	12
7	12
8	6
3	6
3	5
5	5
3	12
3	7
5	7
2	6
3	2
4	2
3	4
4	4
9	2
11	2

Problem 2:

Number of rectangles: 17

4	1
4	5
9	4
3	5
3	9
1	4
5	3
4	1
5	5
7	2
9	3
3	13
2	8
15	4
5	4
10	6
7	2

Problem 3:

Number of rectangles: 16

4	14
5	2
2	2

9	7
5	5
2	5
7	7
3	5
6	5
3	2
6	2
4	6
6	3
10	3
6	3
10	3

Category 2:

25 items, object: 40 x 15

Problem 1:

Number of rectangles: 25

11	3
13	3
9	2
7	2
9	3
7	3
11	2
13	2
11	4
13	4
3	5
11	2
2	2
11	3
2	3
5	4
6	4
12	2
1	2
3	5
13	5
12	4
1	4
5	2
6	2

Problem 2:

Number of rectangles: 25

11	2
2	3
10	7
8	4
9	5
7	2
4	1
6	1

4	5
8	3
1	3
5	5
3	1
12	4
6	2
2	4
11	4
10	2
3	2
11	2
3	4
26	4
8	4
3	2
6	2

Problem 3:

Number of rectangles: 25

12	7
7	7
7	1
5	1
3	2
6	2
7	2
5	2
3	1
6	1
12	6
9	6
12	2
7	2
10	3
4	1
5	1
16	3
5	3
4	2
5	2
10	3
9	3
16	3
5	3

Category 3:

28 or 29 items, object: 60 x 30

Problem 1:

Number of rectangles: 28

7	5
14	5

14	8
4	8
21	13
7	11
14	11
14	5
4	5
18	3
21	3
17	11
4	11
7	4
5	4
6	7
18	5
3	5
7	3
5	3
18	4
3	4
12	2
6	2
18	5
21	5
17	3
4	3

Problem 2:

Number of rectangles: 29

18	6
12	2
7	10
23	4
1	4
7	7
4	11
5	6
7	2
11	6
19	10
5	11
2	4
5	7
2	4
12	7
13	7
6	3
10	6
16	9
4	1
10	4
24	6
9	9
1	2
5	8
5	3
25	7
21	5

Problem 3:

Number of rectangles: 28

24	9
8	9
11	9
17	9
24	4
8	4
6	1
5	1
17	4
6	3
5	3
5	12
13	12
14	14
14	2
2	2
3	8
9	8
14	12
2	12
3	6
9	6
5	2
13	2
18	3
14	3
16	3
12	3

Category 4:

49 items; object: 60 x 60

Problem 1:

Number of rectangles: 49

2	7
24	7
16	4
18	4
16	7
18	7
2	4
24	4
4	28
6	18
14	12
2	12
18	19
9	8
7	8
9	11
7	11
14	6
2	6
6	10
16	10
3	5

4	5
8	12
3	18
3	3
8	3
5	20
3	17
3	7
5	7
3	7
4	7
4	21
10	19
4	17
8	17
3	10
5	10
7	6
8	6
15	12
3	12
11	10
5	10
4	2
8	2
10	2
12	2

Problem 2:

Number of rectangles: 49

10	14
3	13
28	5
5	8
14	9
12	14
13	10
3	17
1	5
4	1
18	4
1	1
2	6
4	14
3	18
4	14
8	17
11	5
9	12
4	7
25	8
7	5
24	9
9	14
12	19
2	4
2	7
3	4
5	30

5	3
10	26
6	5
4	9
1	4
9	2
4	17
5	2
4	4
6	2
4	10
2	4
3	12
6	5
3	9
7	18
6	6
18	7
13	9
25	7

Problem 3:

Number of rectangles: 49

10	4
12	4
13	5
3	5
7	22
6	22
9	23
10	19
3	15
5	13
2	10
2	10
13	18
3	18
2	3
2	3
5	2
4	2
3	4
9	4
7	1
6	1
2	4
20	4
4	7
12	7
9	4
4	4
9	9
2	5
20	5
9	5
4	5
4	2
12	2

3	15
21	11
11	3
3	3
11	23
11	23
11	8
3	8
21	4
14	4
3	13
35	13
11	5
11	5

Category 5:

Category 5: 73 items; object: 60 x 90

Problem 1:

Number of rectangles: 73

6	34
3	13
5	13
12	10
12	10
7	6
15	6
7	25
15	25
12	21
7	16
5	16
3	21
5	21
7	5
5	5
1	4
10	4
13	6
13	12
9	12
6	23
3	7
5	7
1	2
10	2
6	6
5	6
7	14
6	14
3	16
5	16
6	14
5	14
13	14
2	3
7	3
2	11
7	11

7	6
6	6
14	33
4	12
3	12
18	16
3	12
18	12
4	4
3	4
1	3
2	3
9	6
9	6
1	6
2	6
7	5
18	5
9	3
9	3
18	9
5	6
2	6
12	2
9	2
3	8
9	8
9	10
5	3
2	3
18	3
7	3
3	2
9	2

Problem 2:

Number of rectangles: 73

3	5
14	3
9	27
6	24
21	7
7	10
1	2
13	19
4	17
4	13
17	3
24	10
5	4
2	2
6	1
11	9
4	26
2	1
4	7
7	38
3	2
3	1

4	2
4	6
2	1
1	2
5	1
1	1
3	3
5	20
6	23
7	2
11	21
8	7
6	15
2	1
13	14
3	14
5	26
9	14
10	3
4	13
1	3
14	11
7	10
14	12
18	3
7	4
2	7
7	28
30	10
14	19
4	26
3	3
5	23
5	20
15	4
10	6
6	3
5	2
4	2
3	1
2	3
14	3
9	2
7	8
32	6
6	2
26	5
1	2
6	5
13	3
10	3

Problem 3:

Number of rectangles: 73

6	37
10	15
4	7
12	7

4	18
10	8
5	8
4	25
5	25
4	8
12	8
10	10
5	10
3	4
7	4
7	10
2	10
7	15
4	18
15	18
3	18
7	18
7	5
2	5
4	11
5	11
4	5
5	5
1	3
6	3
1	4
6	4
4	2
5	2
19	25
5	9
4	9
3	6
3	6
6	13
20	13
3	18
3	18
5	16
4	16
6	11
13	4
7	4
13	7
3	2
4	2
3	5
4	5
4	24
15	12
13	12
19	7
9	7
5	4
2	4
12	5
9	22
5	1
2	1

15	12
13	12
2	5
5	5
12	17
2	12
5	12
4	5
28	5

Category 6:

97 items; object: 80 x 120

Problem 1:

Number of rectangles: 97

30	19
8	5
13	5
15	23
9	4
3	4
2	11
9	7
3	7
8	14
11	6
2	6
11	8
2	8
12	12
2	12
30	10
21	10
15	6
14	6
2	9
22	9
6	16
5	2
5	2
11	6
9	30
10	8
10	8
5	4
5	4
4	14
2	14
4	22
8	14
3	14
10	22
4	20
6	20
2	7
13	2
9	2
13	5

9	5
17	11
7	11
6	18
4	8
2	8
5	7
3	7
3	14
17	7
7	7
5	7
3	7
6	6
4	6
4	2
6	2
9	61
6	8
5	8
5	2
4	2
5	28
4	28
6	29
3	20
21	20
10	39
4	13
7	13
6	22
5	22
4	26
7	26
3	9
21	9
11	31
9	31
6	28
3	19
18	8
3	8
18	11
3	11
10	18
2	6
9	6
2	12
9	12
3	9
12	2
9	2
12	7
9	7

Problem 2:

Number of rectangles: 97

7	39

8	33
7	6
5	3
3	5
39	6
11	13
3	4
2	2
5	2
5	30
2	1
26	11
4	5
9	2
10	29
4	3
5	5
8	2
24	4
22	7
2	9
2	2
5	1
9	15
10	33
1	1
4	4
3	3
4	4
3	6
16	7
6	4
6	2
15	3
30	5
1	1
10	4
2	6
6	23
29	8
26	5
9	17
7	3
19	9
36	6
28	6
6	20
20	7
11	2
6	5
5	13
4	14
16	8
23	9
26	8
1	6
15	26
4	25
8	45
11	50

19	5
12	55
5	20
4	13
15	5
2	6
4	26
12	6
3	1
2	3
3	2
1	1
2	3
3	2
5	2
4	4
8	2
9	11
3	2
5	11
7	9
24	30
2	11
10	8
9	2
10	2
3	11
4	22
6	9
3	3
7	18
5	15
9	13
2	10
6	5
17	5

Problem 3:

Number of rectangles: 97

6	35
1	6
6	6
34	13
10	7
23	7
1	7
6	7
10	62
10	33
13	33
7	22
4	15
6	8
24	8
6	7
24	7
4	7
30	7
6	34

8	17
10	17
8	16
15	16
5	6
5	6
9	21
4	21
5	23
5	23
8	6
15	6
8	5
10	5
5	4
7	2
6	2
6	4
17	4
7	2
6	2
5	8
4	4
9	4
6	8
17	8
4	6
5	6
4	8
4	4
9	4
4	2
5	2
4	25
6	25
6	6
2	6
18	10
11	24
9	4
17	4
7	9
9	5
17	5
6	4
2	4
6	8
20	8
7	42
8	14
18	14
6	34
5	9
8	7
7	7
26	20
5	7
3	7
3	15
8	2

7	2
4	19
6	19
5	25
8	13
7	13
5	8
3	8
8	5
3	5
6	8
2	8
7	12
10	7
37	7
6	4
2	4

Category 7:

Category 7: 196 or 197 items; object: 160 x 240

Problem 1:

Number of rectangles: 196

19	21
6	21
6	18
41	18
22	14
13	14
8	13
14	13
31	20
8	7
14	7
22	54
13	54
6	23
8	13
33	13
6	22
5	22
11	28
19	56
12	56
16	11
3	11
6	20
8	10
33	10
16	9
3	9
8	4
17	4
20	9
19	9
8	15
6	6
5	6

3	6
5	6
17	23
5	28
6	28
11	53
20	6
19	6
3	17
5	17
39	12
8	12
31	8
41	8
23	23
12	23
9	9
16	9
6	18
20	13
21	13
5	25
6	25
19	25
7	16
5	16
9	9
16	9
20	12
21	12
23	10
12	10
7	9
5	9
25	7
6	7
16	47
16	14
8	14
21	16
2	4
4	4
11	11
29	11
10	54
13	54
13	70
7	13
3	13
7	25
2	12
4	12
11	32
22	9
7	9
7	12
3	12
16	33
8	33
14	21

7	21
6	27
6	10
16	10
7	23
10	45
7	45
2	10
4	10
16	13
14	6
7	6
2	3
4	3
13	13
14	13
7	8
33	8
16	34
12	28
12	28
7	30
4	19
29	19
10	51
13	51
13	25
4	21
10	21
4	11
29	11
9	26
4	26
17	35
12	6
12	6
4	4
10	4
8	10
13	2
6	2
10	12
3	12
22	16
18	16
7	20
17	16
3	16
13	8
6	8
8	10
19	10
10	8
3	8
9	9
4	9
22	14
9	7
9	7
17	4

3	4
19	17
8	17
8	11
5	11
7	10
20	10
9	7
9	7
19	20
4	20
4	10
26	10
19	11
21	11
3	3
6	3
18	13
8	27
5	27
3	10
6	10
4	24
5	21
21	21
19	21
8	21
19	17
21	17
9	15
5	6
13	6
19	14
4	14
5	9
4	7
9	7
5	3
21	3
4	2
9	2

Problem 2:

Number of rectangles: 197

15	75
12	80
27	6
3	13
10	3
9	21
8	11
6	13
2	9
51	10
6	6
11	12
2	10
8	12
13	47

14	37
3	11
3	6
1	4
1	6
27	5
14	3
10	4
5	20
3	11
14	5
5	2
7	2
12	9
2	1
12	8
5	28
8	6
35	7
7	14
10	45
4	19
13	17
62	9
36	11
38	18
4	2
9	5
8	3
30	20
6	7
36	10
27	7
17	3
6	4
11	10
5	25
7	26
10	44
19	4
8	31
33	6
11	73
8	27
6	2
2	9
25	9
9	39
9	17
12	7
21	101
3	10
3	7
4	10
8	22
5	3
2	1
1	2
22	59
1	2

1	1
2	1
11	56
10	39
5	5
3	20
2	1
2	7
7	6
13	12
17	34
16	46
1	1
6	13
3	12
6	10
9	15
6	24
1	1
5	7
4	1
2	13
11	9
1	6
3	16
7	11
8	15
6	10
6	21
3	9
1	4
10	7
3	3
5	15
2	4
33	8
16	5
9	12
10	11
6	3
10	11
39	8
17	113
13	36
28	8
17	7
42	9
22	57
2	1
15	9
30	8
26	7
16	32
71	25
12	25
22	20
9	55
13	27
65	16
1	3

5	2
16	57
2	1
3	3
3	2
25	11
11	8
6	4
10	9
25	8
10	6
12	15
6	19
2	4
4	7
4	2
6	7
13	3
29	5
2	2
8	15
5	28
8	42
4	27
3	2
18	4
17	5
2	8
2	11
1	2
3	18
17	10
7	5
3	10
5	31
19	9
7	8
10	3
11	37
1	4
6	32
1	5
12	5
7	33
2	8
6	11
9	9
4	27
10	11
38	9
5	7
6	2
3	6
6	2
32	5
12	4
16	3
72	15
14	14
2	6

3	9
12	3

Problem 3:

Number of rectangles: 196

19	15
4	15
8	5
26	5
21	10
5	24
3	7
32	7
26	92
16	92
8	5
26	5
3	17
32	17
10	5
24	5
2	8
19	8
3	7
3	7
13	10
4	27
10	14
24	14
2	11
19	11
3	3
3	3
5	5
35	5
6	17
13	17
24	8
31	8
5	8
35	8
24	5
31	5
5	5
35	5
11	44
12	44
38	17
57	17
13	5
17	5
8	17
36	20
21	20
13	12
17	12
5	15
10	6

15	6
8	50
30	16
6	16
15	10
6	10
10	9
15	9
6	8
5	8
12	40
9	33
6	33
6	37
5	35
21	13
4	13
4	17
22	17
16	34
6	32
5	32
14	23
16	23
6	31
21	22
4	22
4	17
22	17
14	8
16	8
9	4
6	4
20	4
22	4
5	29
38	7
33	7
7	32
5	32
30	49
5	22
9	22
6	37
6	31
16	31
2	7
25	7
11	12
33	22
2	5
25	5
27	10
11	10
5	15
9	15
5	30
11	13
30	13
30	21

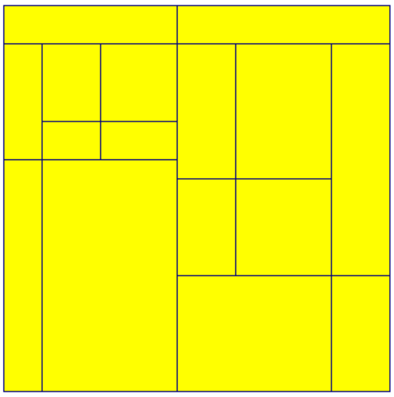
7	17
5	17
6	24
6	22
10	22
3	2
3	2
8	10
6	18
11	8
30	8
3	8
3	8
12	65
5	5
16	5
6	9
3	9
41	9
17	3
13	3
6	8
8	8
17	6
13	6
5	11
16	11
6	2
10	2
6	7
3	7
8	10
14	3
12	3
3	3
5	3
10	26
4	10
47	10
3	11
12	11
14	7
12	7
3	18
5	18
12	10
9	10
9	49
5	7
3	7
26	11
4	8
47	8
3	7
12	7
12	39
9	39
5	4
3	4
51	8

15	8
7	4
2	4
25	11
8	34
7	7
2	7
10	29
2	10
5	10
59	19
9	23
22	15
3	15
2	9
4	7
1	7
4	2
1	2
7	10
59	10
22	8
3	8

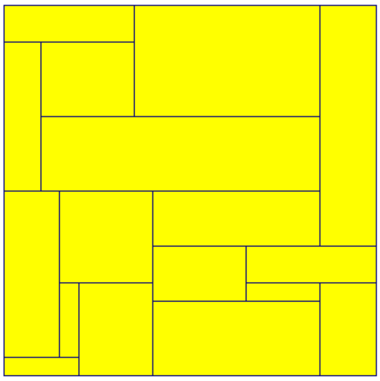
4. Optimal layout of test problems

Category 1:
Optimum object: 20x20

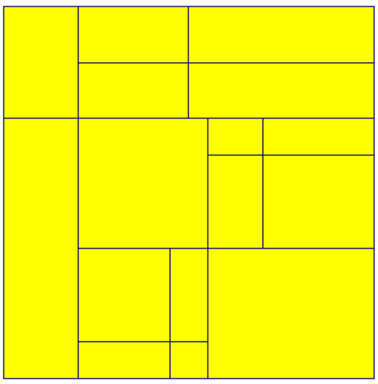
Problem 1:
16 rectangles



Problem 2:
17 rectangles



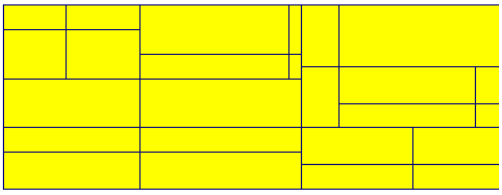
Problem 3:
16 rectangles



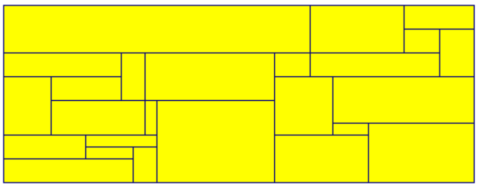
Category 2:

Optimum object: 40x15

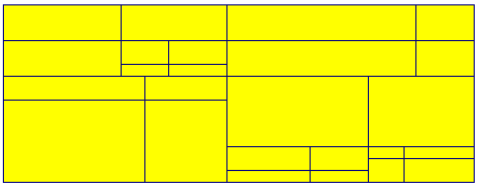
Problem 1:
25 rectangles



Problem 2:
25 rectangles

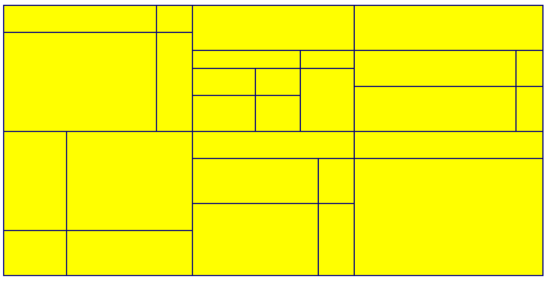


Problem 3:
25 rectangles

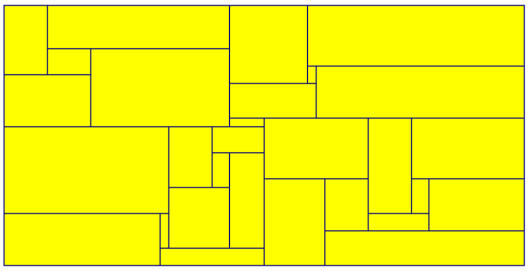


Category 3:

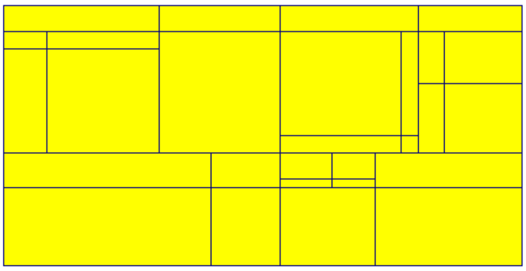
Problem 1:
28 rectangles



Problem 2:
29 rectangles



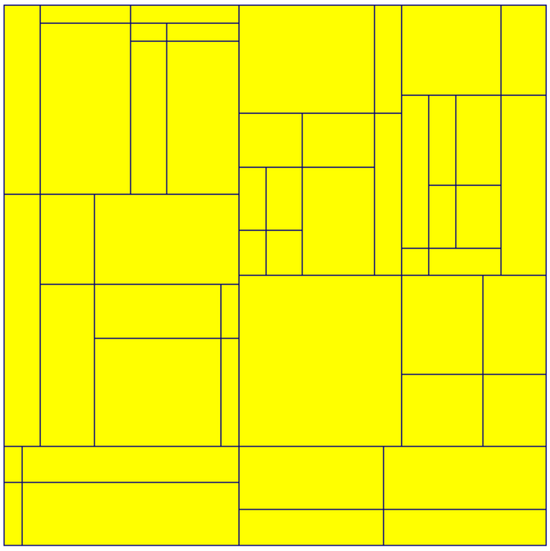
Problem 3:
28 rectangles



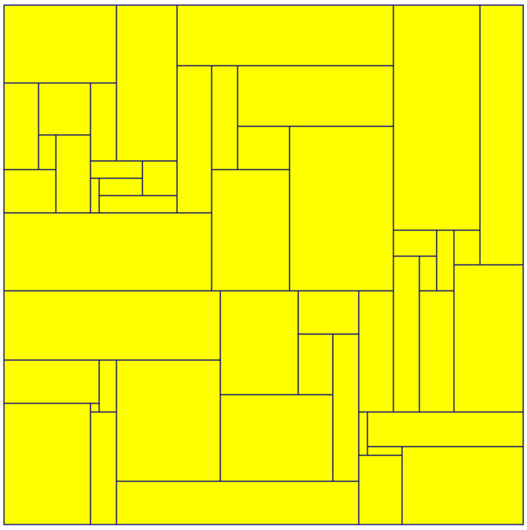
Category 4:

Optimum object: 60 x 60

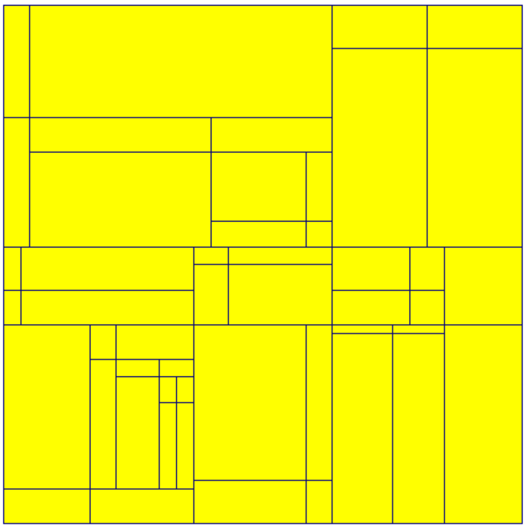
Problem1:
49 rectangles



problem 2:
49 rectangles



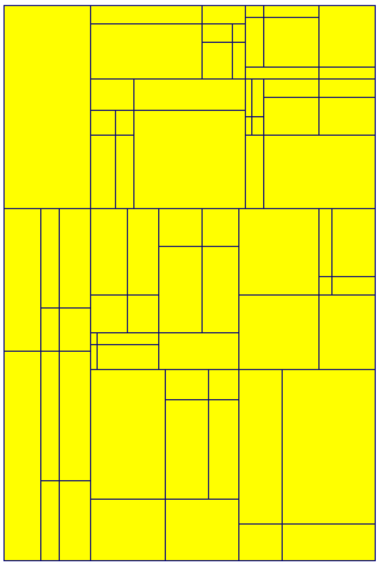
problem 3:
49 rectangles



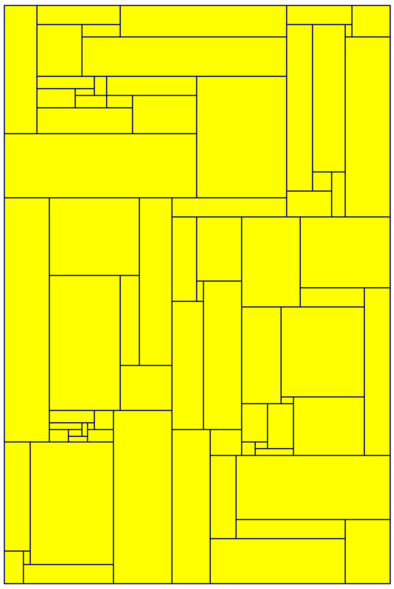
Category 5:

Optimum object: 60x90

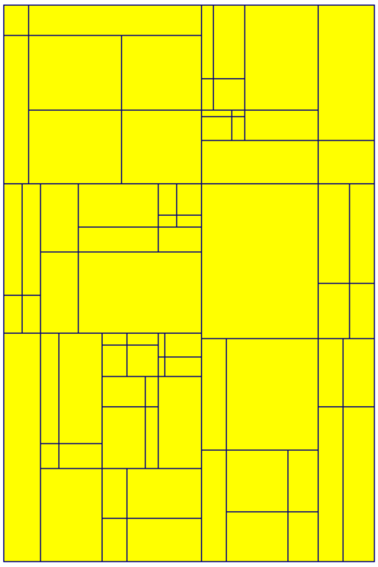
Problem 1:
73 rectangles



Problem 2:
73 rectangles



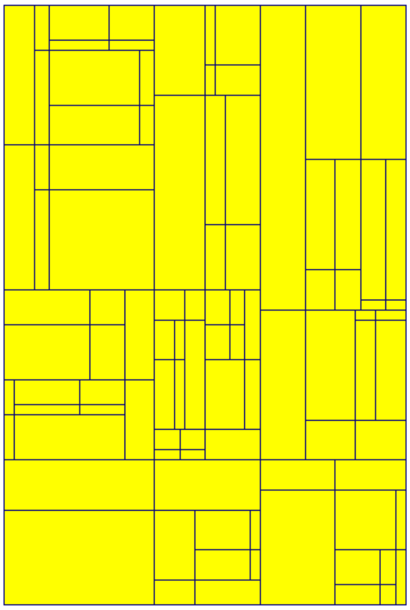
Problem 3:
73 rectangles



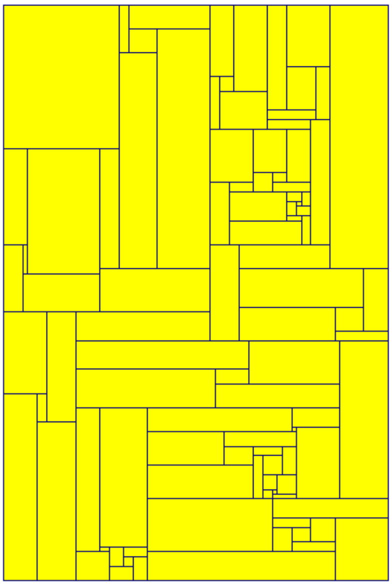
Category 6:

Optimum object: 80x120

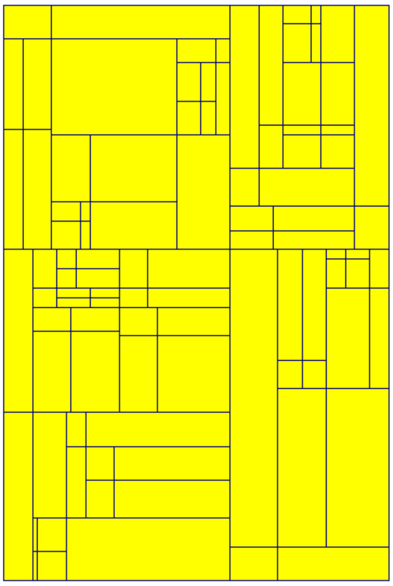
Problem 1:
97 rectangles



problem 2:
97 rectangles



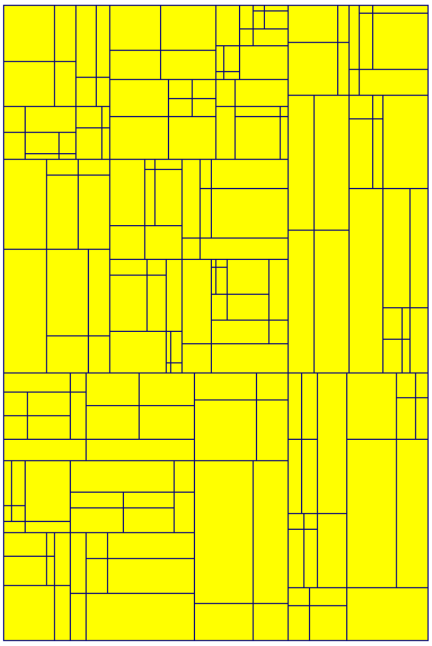
problem 3:
97 rectangles



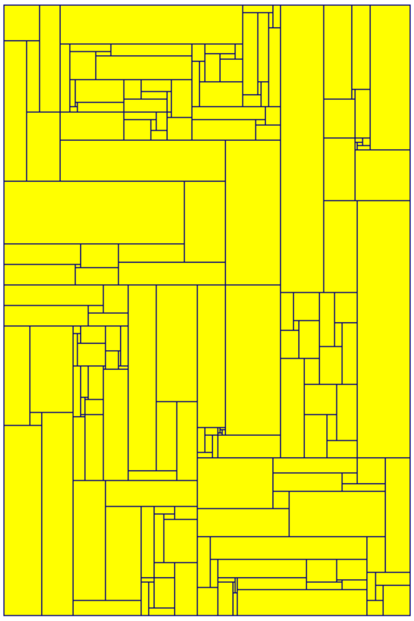
Category 7:

optimum object 160x240

Problem1:
196 rectangles



Problem 2:
197 rectangles



Problem3:
196 rectangles