Two-dimensional irregular bin packing problem

We are given a finite set of N items $P = \{P_1, P_2, \ldots, P_N\}$ and an infinite set of bins $B = \{B_1, B_2, \ldots\}$. Items presented as a two-dimensional, possibly non-convex polygons. Each polygon is presented as a set of vertices $p \in P_i$ with coordinates (x^p, y^p). The length and width of bins are given and equal to L and W, respectively. We need to pack all items without overlapping while minimizing the number of used bins. The rotations of items by 0°, 90°, 180° and 270° angles are allowed.

To distinguish solutions with the same number of bins, but with the different percent of the residuals at the last bin, we apply the following objective function.

$$\max \frac{\sum_{i=1}^{N} U_i^2}{N}, \tag{1}$$

where U_i is the utilisation ratio of bin i, N is a number of the used bins. The U_i is defined as $U_i = \frac{\sum_{i=1}^{n} Sqr(P_i)}{LW}$, where $Sqr(P_i)$ is the area of the item P_i if it is packed in the bin i, 0 otherwise.

Irregular strip packing problem is in a group of problems which are called as nesting problems. They deal with a lot of applications in textile, sheet metal, leather, glass and other industries. In these cases, we want to cut all pieces and to spend less material.

Information about the data sets

Presented data sets consist of polygons which are the templates for a car mates production. In this data sets the templates of car mates for trunks and for different parts of the cabin is presented. For example, data set car_mats_5 consist of the trunks mates only, car_mats_9 consist of templates of mats which is located in the middle of a back row of the car.

The source data is contained in text files car_mats1.txt – car_mats10.txt. Each file contains information about all the polygons of the data set one by one. All data set consists of 50 polygons. For each polygon, we have the following information. The line after the word PIECE indicates the ID of the item. On the next line, after the word QUANTITY, we specify the number of polygons in the data set. In the next line, we record the NUMBER OF VERTICES of this polygon. This value will equal the number of lines with the coordinates. Next line VERTICES (X,Y) indicates that the next lines will present the coordinates of each point by axis X and by axis Y. After the coordinates of the one item will be the same information about the next item.

Input data	Types of items	Illustration	The best found valu
car_mats_1.txt	10 types × 5	car_mats_data_set_1.png	0.421
car_mats_2.txt	10 types × 5	car_mats_data_set_2.png	0.417
car_mats_3.txt	10 types × 5	car_mats_data_set_3.png	0.414
car_mats_4.txt	10 types × 5	car_mats_data_set_4.png	0.416
car_mats_5.txt	25 types × 2	car_mats_data_set_5.png	0.419
car_mats_6.txt	25 types × 2	car_mats_data_set_6.png	0.427
car_mats_7.txt	25 types × 2	car_mats_data_set_7.png	0.412
car_mats_8.txt	25 types × 2	car_mats_data_set_8.png	0.410
car_mats_9.txt	10 types × 5	car_mats_data_set_9.png	0.415
car_mats_10.txt	50 types × 1	car_mats_data_set_10.png	0.425