1 CP model

N_bins: the number of bins given
N_items: the number of items given
W_j, H_j, C_j: the width, height, and cost of bin j, respectively
w_i, h_i: the width, height of item i, respectively

1.1 Decision Variables

* $X_{ij} = 1$: item i packed in bin j

$$\Rightarrow \sum_{i=1}^{\text{N\_items}} X_{ij} \geq 1 \Longleftrightarrow Z_j = 1\text{: bin j has been used}$$

* $R_i = 1$: item i rotated 90 degree

Item's Coordinate:

l_i, r_i, b_i, t_i: left, right, bottom and top coordinates of item i
* First way to approach:
- if item i not rotated: $R_i = 0$

$$\Rightarrow \begin{cases} r_i = l_i + w_i \\ t_i = b_i + h_i \end{cases}$$

- if item i rotated: $R_i = 1$

$$\Rightarrow \begin{cases} r_i = l_i + h_i \\ t_i = b_i + w_i \end{cases}$$

* Another way to approach:
- if item i not rotated: $R_i = 0$

$$\Rightarrow \begin{cases} w_i = w_i \\ h_i = h_i \end{cases}$$

- if item i rotated: $R_i = 1$

$$\Rightarrow \begin{cases} w_i = h_i \\ h_i = w_i \end{cases}$$

1.2 Constraints

1.2.1 Each item has to be packed in exactly 1 bin:

$$\sum_{j=1}^{\text{N\_bins}} X_{ij} = 1, \quad \forall i \in \{1, 2, ..., \text{N\_items}\}$$

1.2.2 No two items overlap:

if $X_{i_1 j} = X_{i_2 j} = 1$

$$r_{i_1} \leq l_{i_2} \text{ or } r_{i_2} \leq l_{i_1} \text{ or } t_{i_1} \leq b_{i_2} \text{ or } t_{i_2} \leq b_{i_1}$$

1.2.3 Items cannot exceed the bin:

if $X_{ij} = 1$

$$\Rightarrow \begin{cases} w_i \leq r_i \leq W_j \\ h_i \leq t_i \leq H_j \end{cases}$$

1.3 Objective Function

$$\textbf{minimize} \sum_{j=1}^{\text{N\_bins}} Z_j * C_j$$