

# 1 CP model

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

$Z_j = 1$ : bin  $j$  has been used

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

$l_i, r_i, b_i, t_i$ : left, right, bottom and top coordinates of item  $i$

## 1.1 Constraints

1. Each item has to be placed in exactly 1 bin:

$$\sum_{j=1}^m X_{ij} = 1 \text{ for } i \text{ in } n$$

2. No two items overlap:

if  $X_{i_1j} = X_{i_2j} = 1$

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

3. If item  $i$  rotated:

if  $R_i = 0$

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

else  $R_i = 1$

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

4. Items cannot exceed the bin:

if  $X_{ij} = 1$

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

## 1.2 Another way to approach

Keep constraints: 1, 2, 4

3. If item  $i$  rotated:

if  $R_i = 0$

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

else  $R_i = 1$

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

I will show how to implement this constraint in CP solver in the solver file.