A **13/6-Approximation** for **Strip Packing** via the **Bottom-Left Algorithm**

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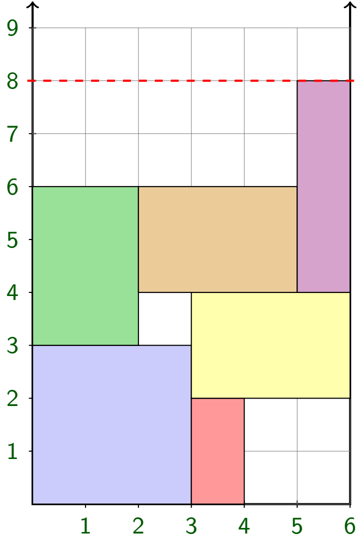
Given : A strip of width W, rectangles $r_1, \ldots, r_n$ of width w_i and height h_i.

Task : Find a minimum height packing of the rectangles into the strip.



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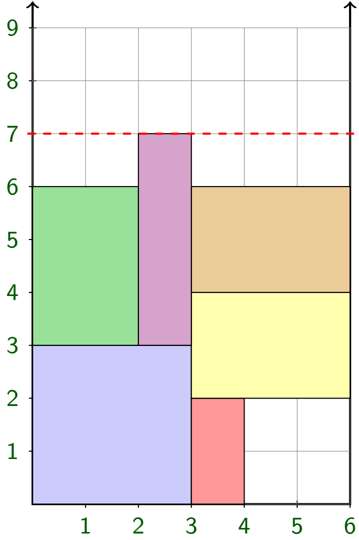

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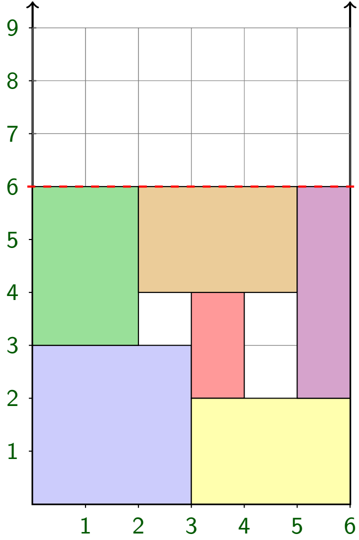

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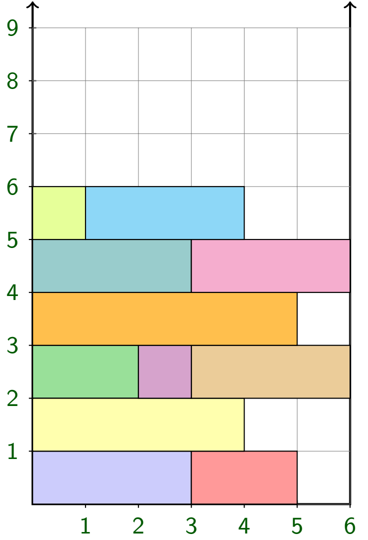

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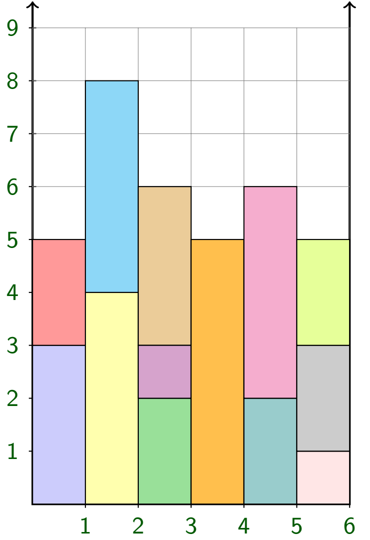

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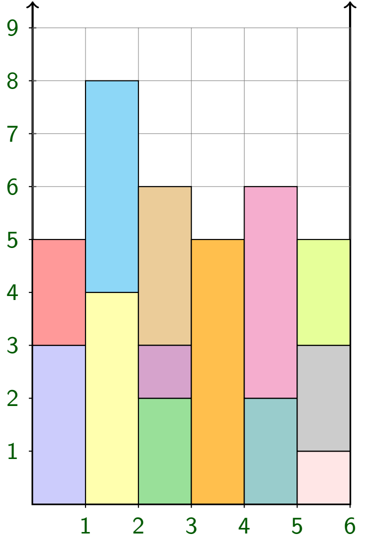

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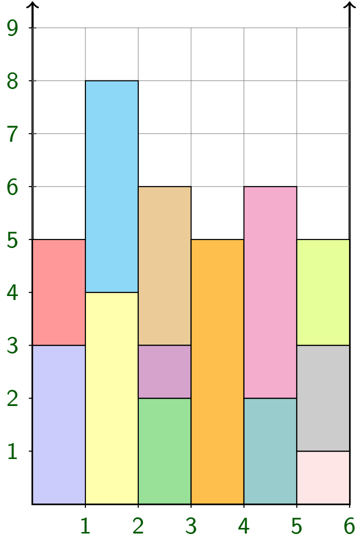

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- Strongly NP-hard
- Unless P=NP, no better-than-$3/2$ approximation

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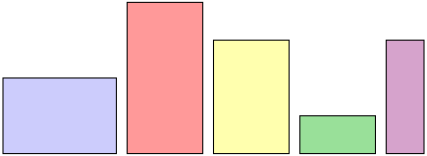

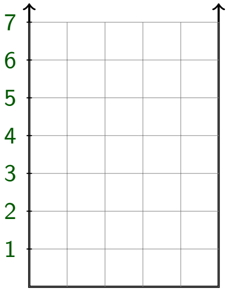

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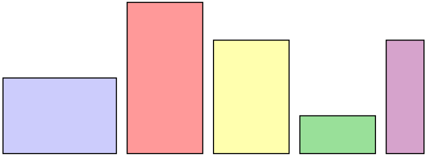

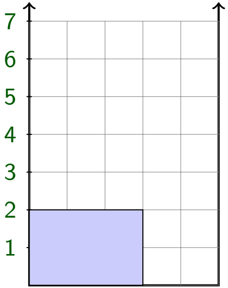

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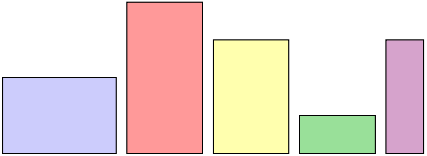

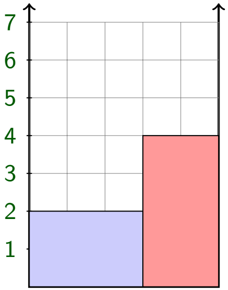

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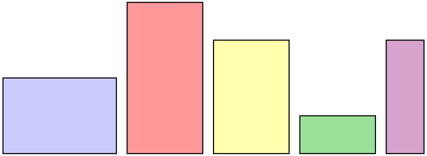

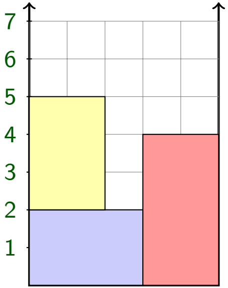

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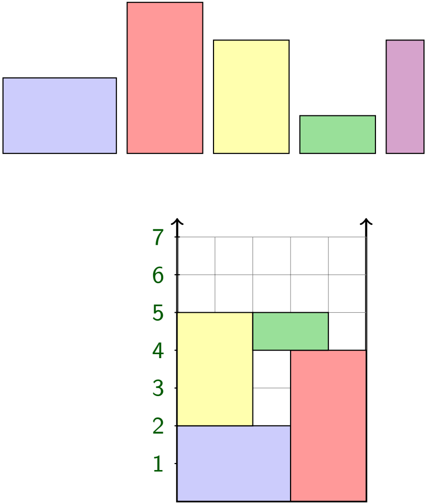

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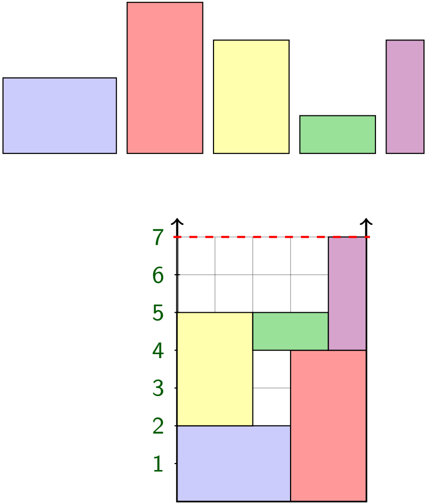

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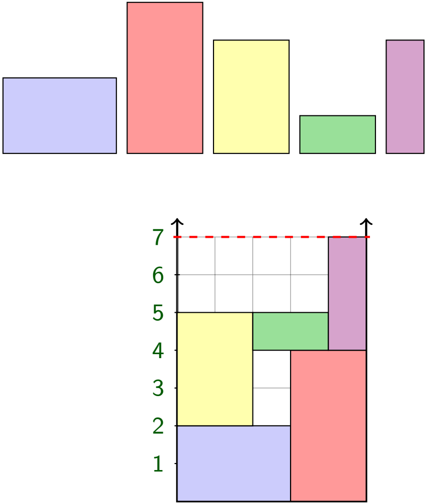

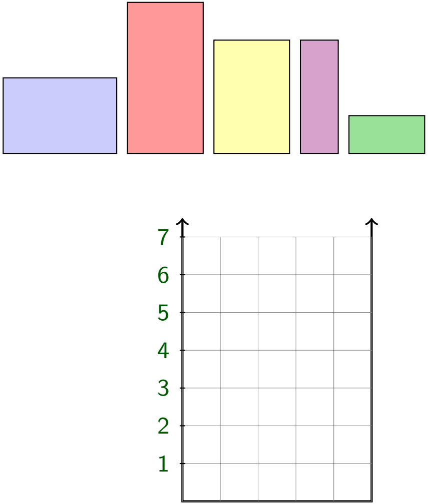

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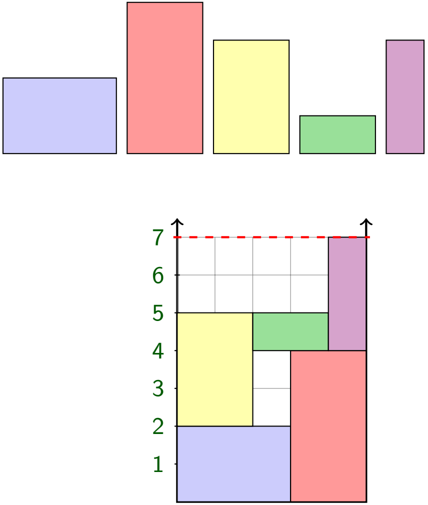

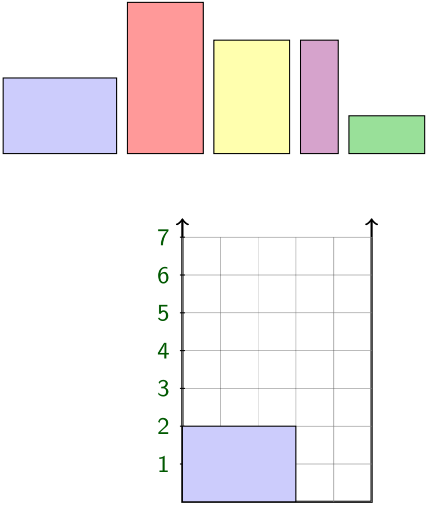

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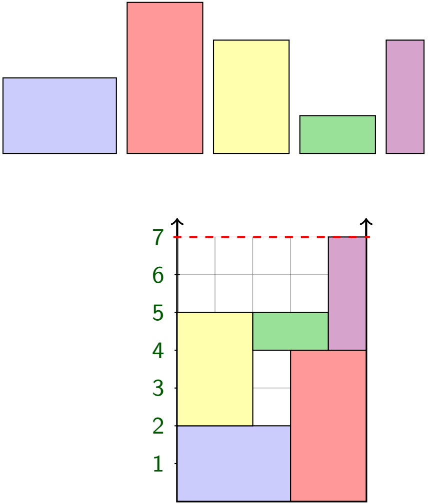

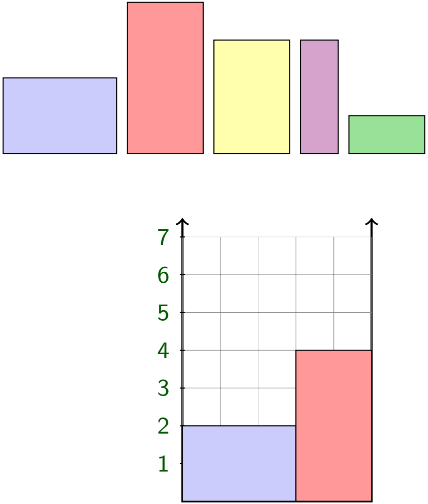

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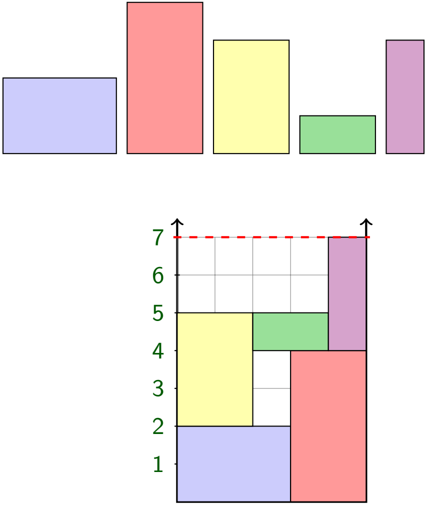

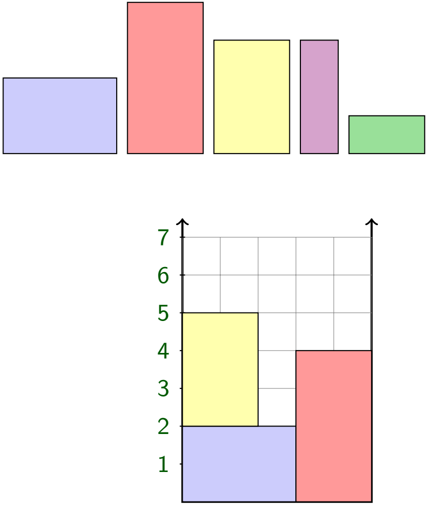

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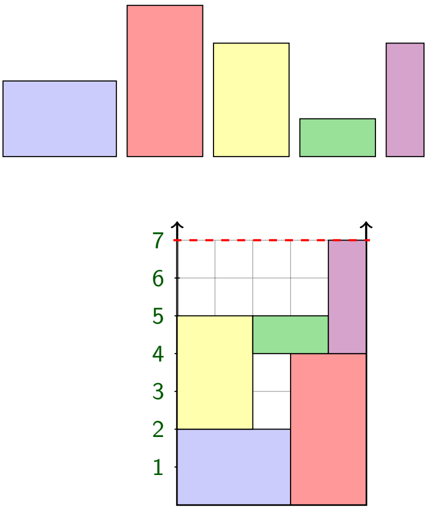

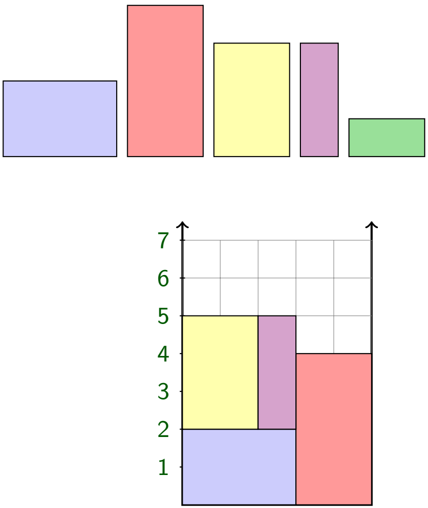

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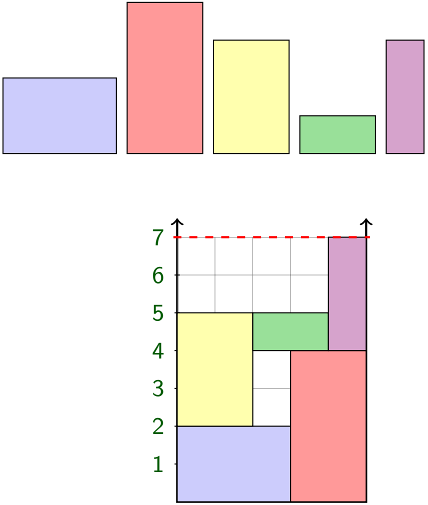

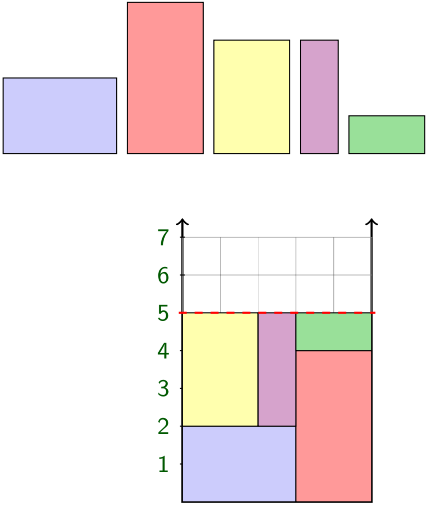

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There are instances ordered best possible: $h_{\text{BL}}^{\text{best}} \geq (\frac{4}{3} - \epsilon) h_{\text{OPT}}$

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$\frac{13}{6} \approx 2.167$

Decreasing width lower bound [Baker, Coffman, Rivest SICOMP 1980]

Checkerboard
There is an instance such that $h_{\mathsf{BL}}^{\text{decr-w}} \geq (3-\epsilon)h_{\mathsf{OPT}}$.

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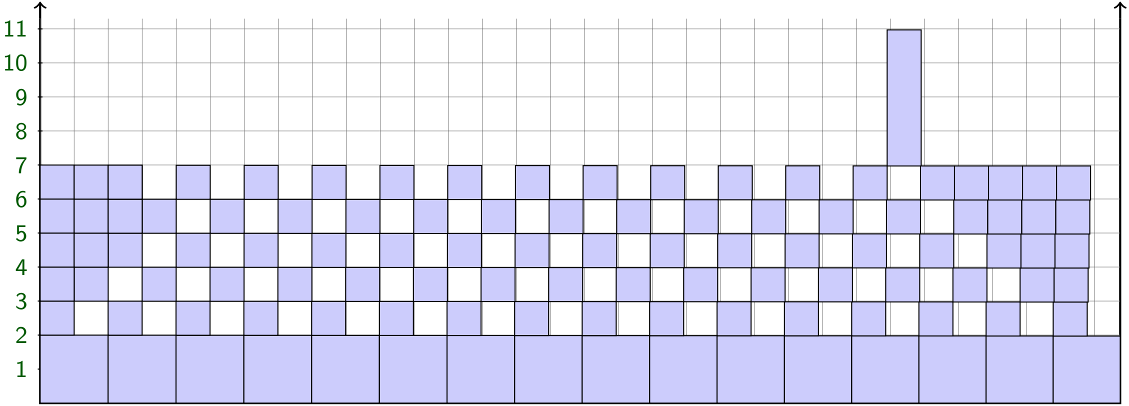

Algorithm $\mathcal{FQW}$-ordering

1: $\mathcal{F} = \varnothing$
2: **for** rectangle r in order of decreasing height **do**
3: **if** $w_r + \sum_{f \in \mathcal{F}} w_f \leq W$ **then**
4: Add r to $\mathcal{F}$

$\mathcal{FQW}$-ordering [Hougardy, Zondervan STACS'26]

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$\mathcal{F}\mathcal{Q}\mathcal{W}$-ordering [Hougardy, Zondervan STACS'26]

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W = {r ∈ R \ F | w_r > ½W}
Q = R \ (W ∪ F)
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return the ordering:
        1. F by decreasing height,
        2. Q by decreasing width,
        3. W in any order
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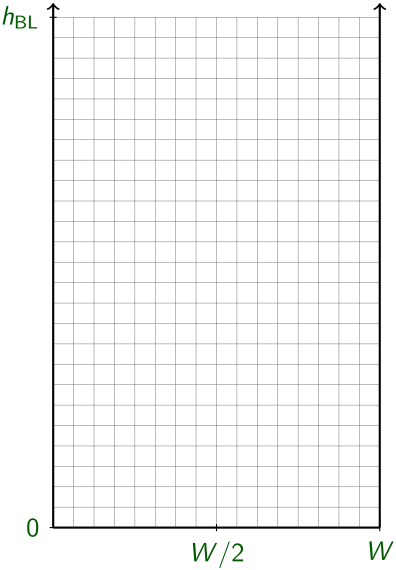
13/6-approximability [Hougardy, Zondervan STACS'26]



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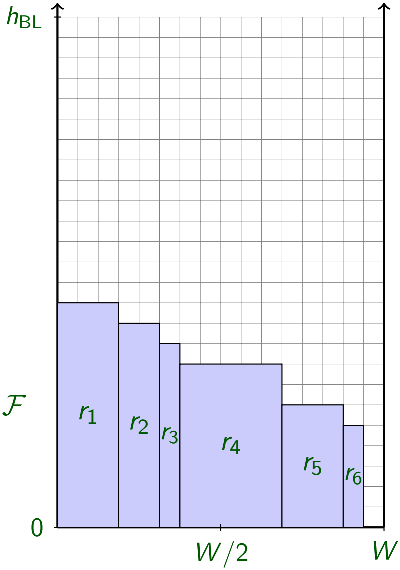

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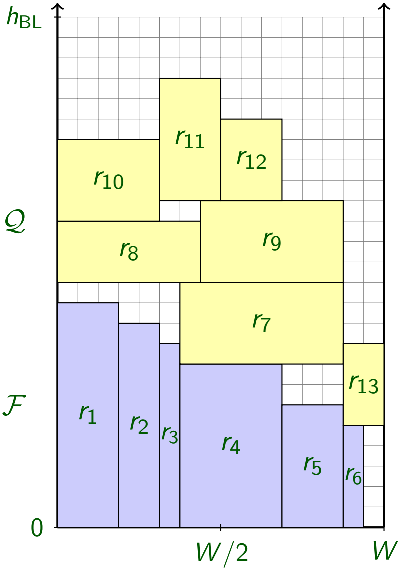

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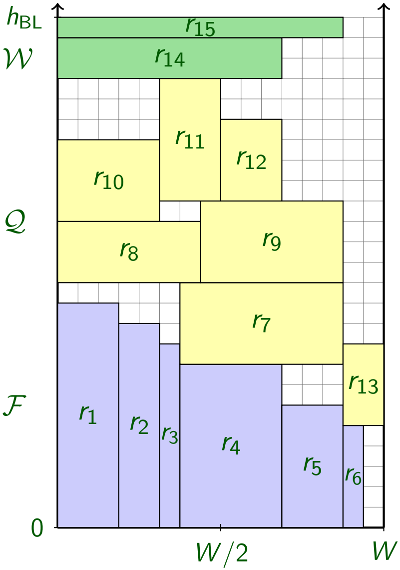

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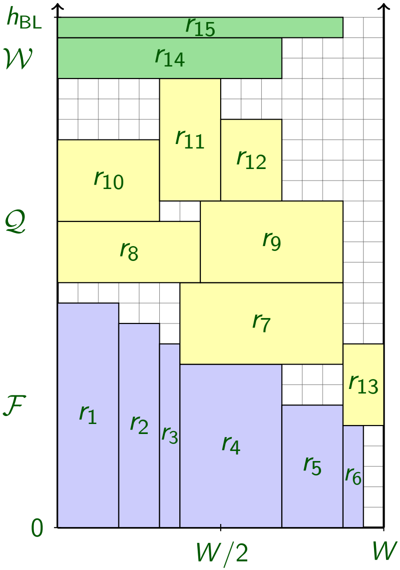

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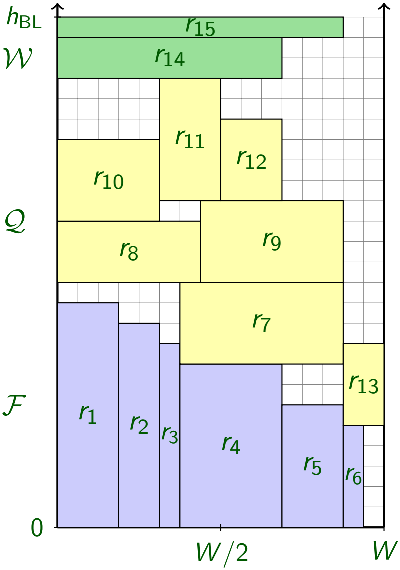

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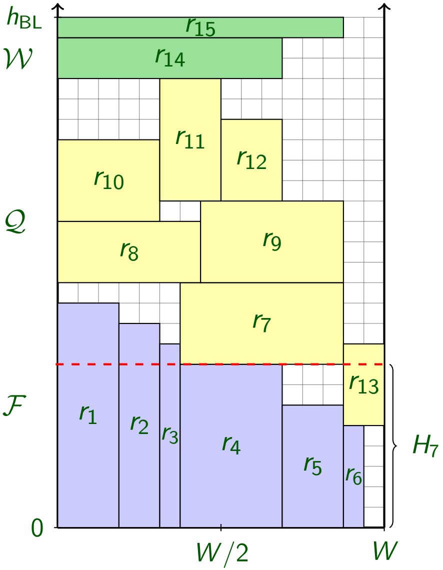

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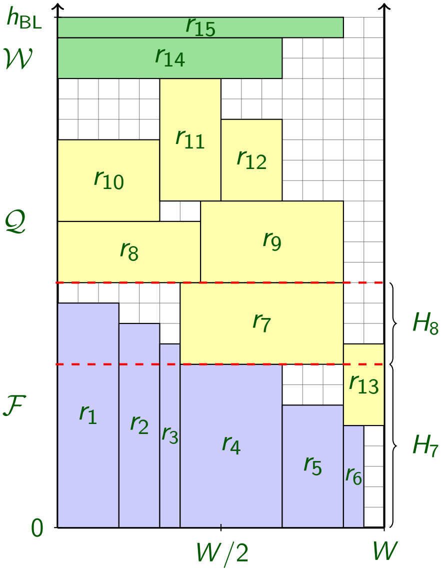

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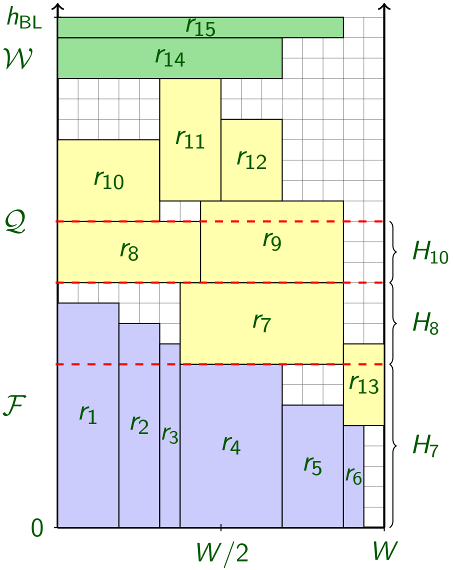

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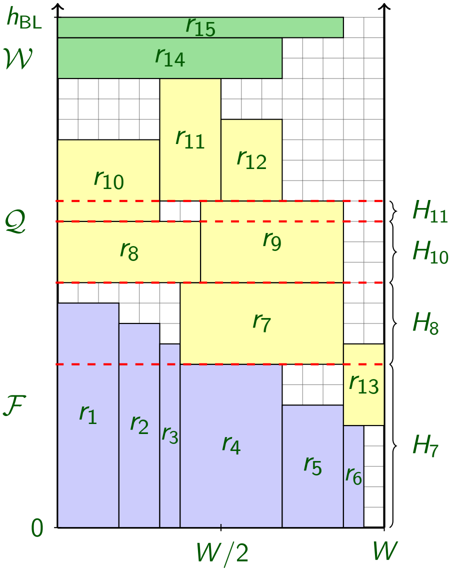

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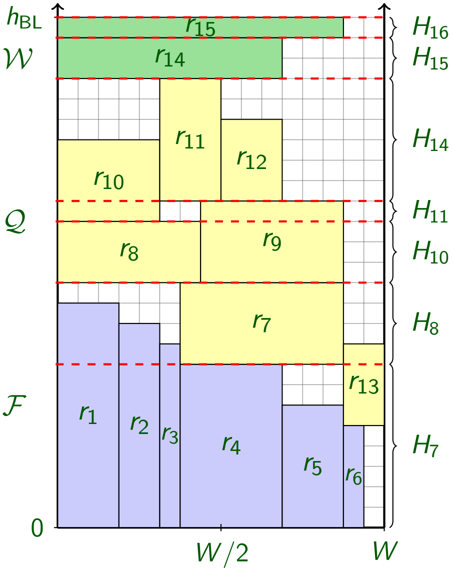

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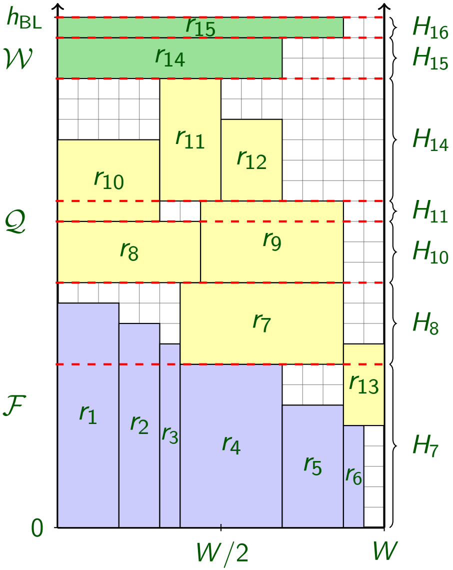

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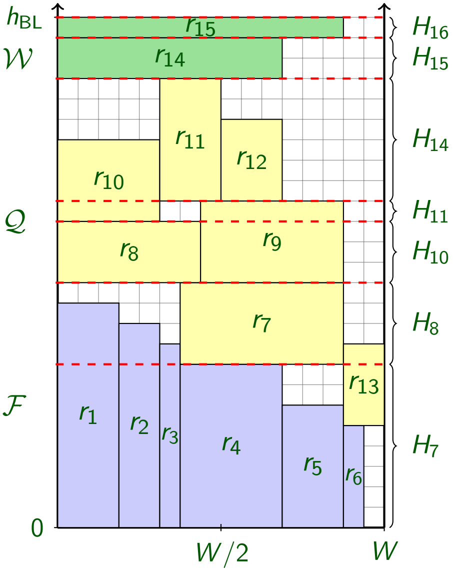

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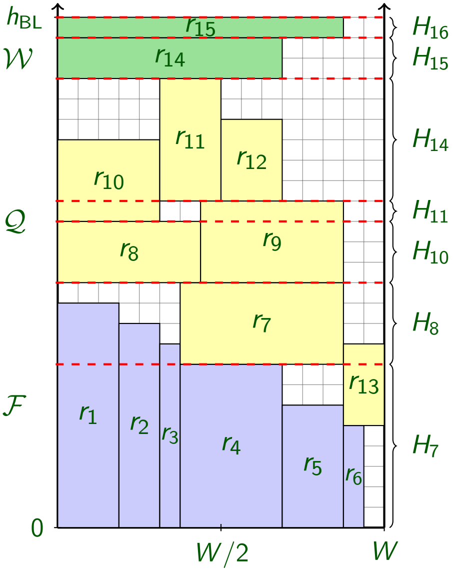

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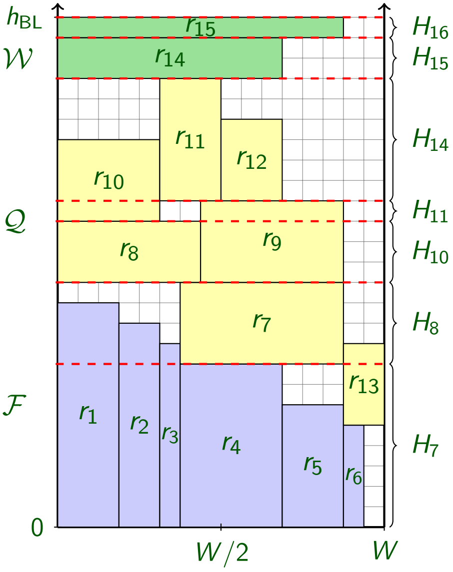

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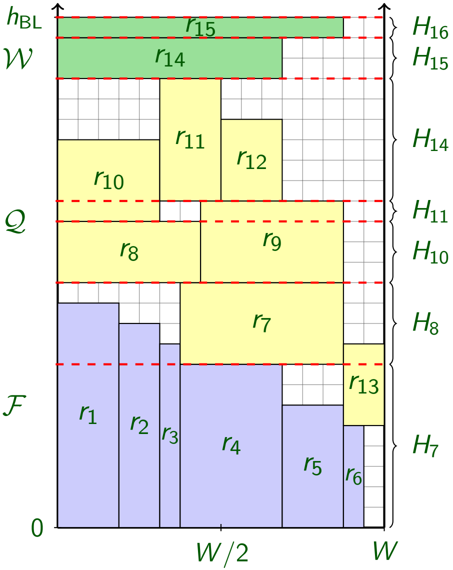

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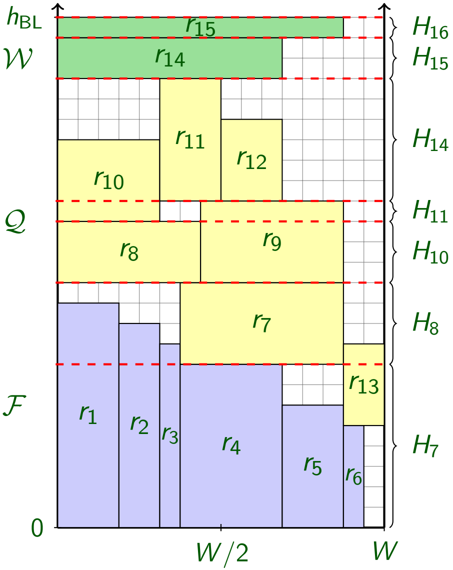

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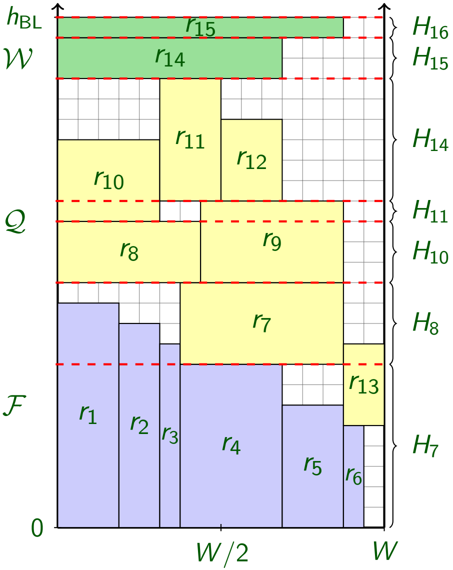

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Suppose that before placing r_i, there is a $\mathcal{Q}$-rectangle in H_i touching the strip boundary.
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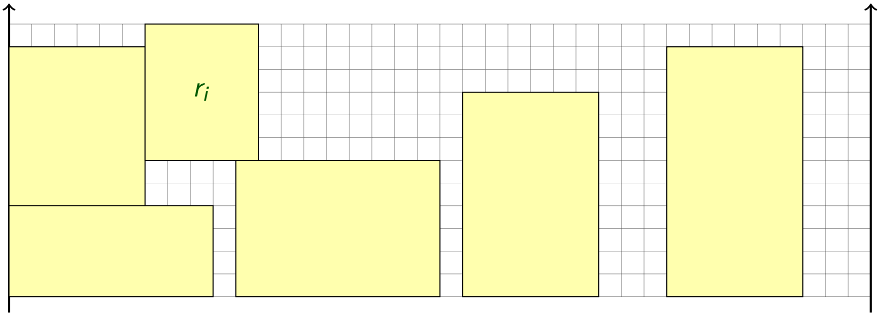

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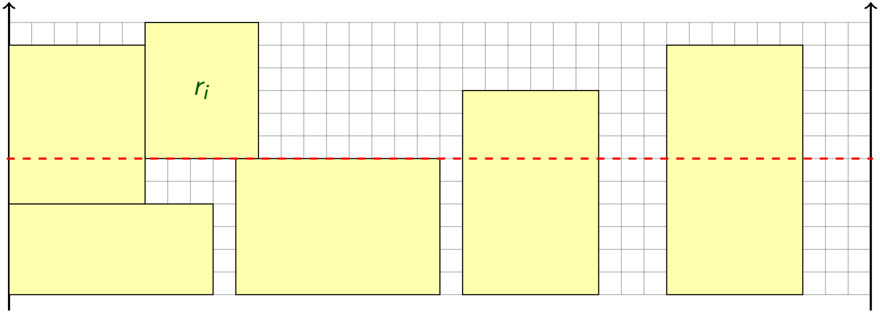

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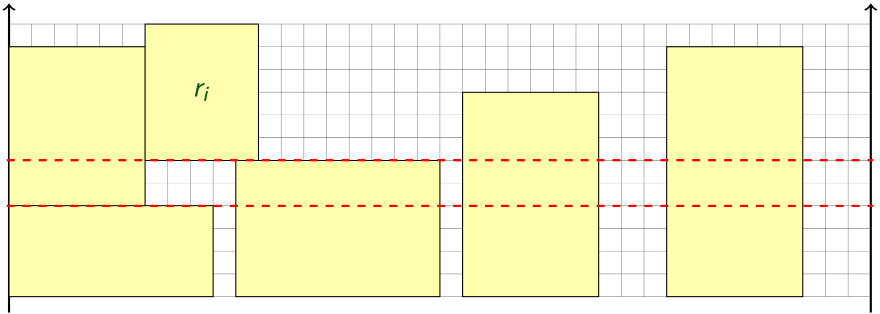

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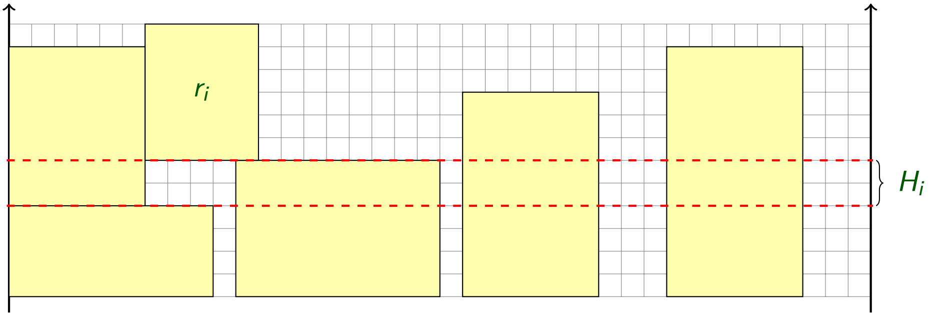

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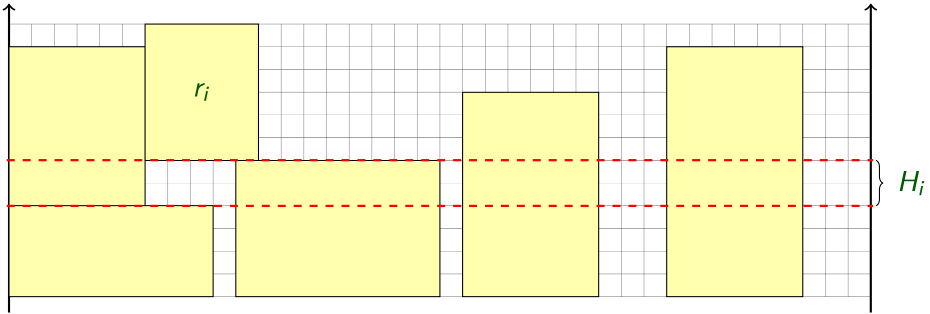

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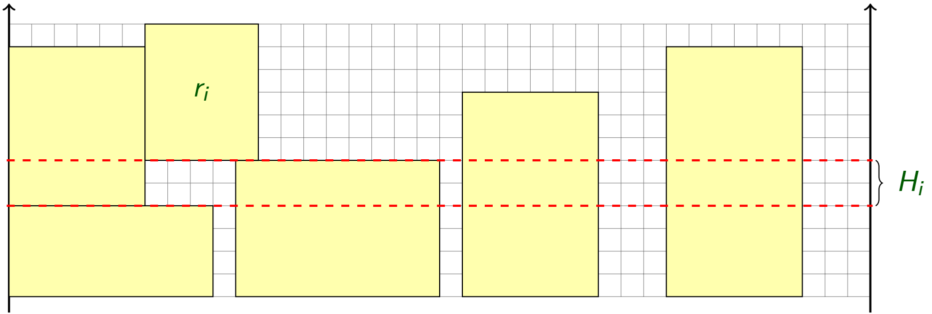

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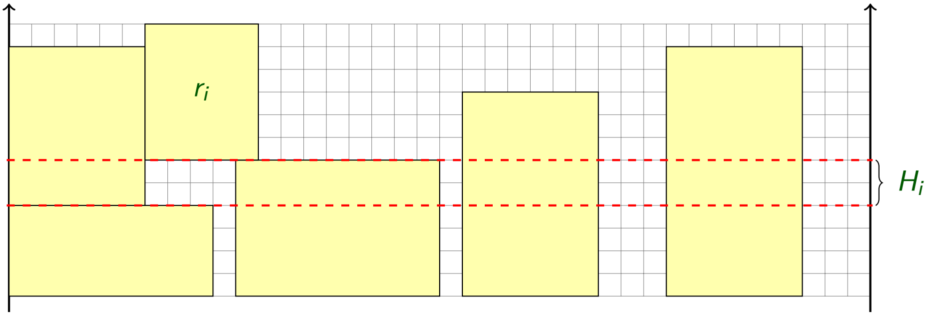

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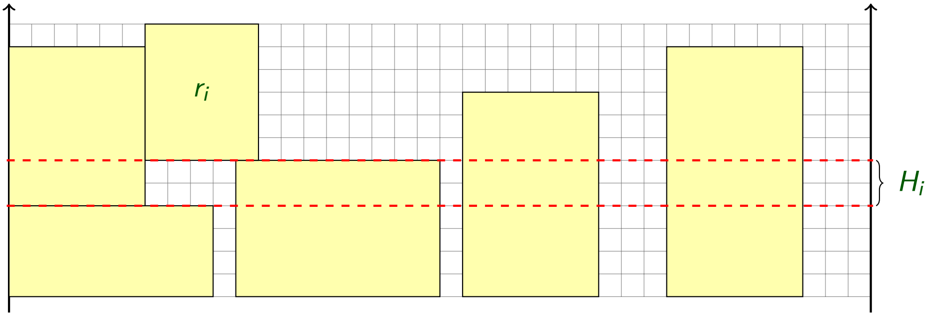
3. Gaps are narrower than r_i



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The union $\bigcup H_i$ of the remaining H_i is at least $\frac{1}{2}\left(\sum h(H_i) - \frac{1}{6} \cdot h_{\mathrm{OPT}}\right) \cdot W$ occupied.

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$$\begin{aligned}
\text{maximize} \quad & \sum_{k=1}^{\infty} \alpha_k \cdot \left(\frac{1}{2}W + \beta_k - \frac{1}{2}\sum_{j=k}^{\infty}\beta_j\right) & \\
\text{subject to} \quad & 0 \leq \alpha_k \leq \frac{1}{2}h_{\mathrm{OPT}} & \text{for all } k \in \mathbb{N}, \\
& \sum_{k=1}^{\infty} \alpha_k \leq h, & \\
& 0 \leq \beta_k \leq \frac{1}{2k+1}W & \text{for all } k \in \mathbb{N}, \\
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Take away message

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