

5.85 cumulative_two_d

DESCRIPTION LINKS

Origin	Inspired by cumulative and diffn .
Constraint	<code>cumulative_two_d(RECTANGLES, LIMIT)</code>
Arguments	$\left(\begin{array}{l} \text{start1-dvar,} \\ \text{size1-dvar,} \\ \text{last1-dvar,} \\ \text{start2-dvar,} \\ \text{size2-dvar,} \\ \text{last2-dvar,} \\ \text{height-dvar} \end{array} \right)$ <p>RECTANGLES : <code>collection</code></p> <p>LIMIT : <code>int</code></p>
Restrictions	<pre>require_at_least(2, RECTANGLES, [start1, size1, last1]) require_at_least(2, RECTANGLES, [start2, size2, last2]) required(RECTANGLES, height) RECTANGLES.size1 ≥ 0 RECTANGLES.size2 ≥ 0 RECTANGLES.height ≥ 0 LIMIT ≥ 0</pre>
Purpose	<p>Consider a set \mathcal{R} of rectangles described by the RECTANGLES collection. Enforces that at each point of the plane, the cumulated height of the set of rectangles that overlap that point, does not exceed a given limit.</p>
Example	$\left(\left\langle \begin{array}{cccccccc} \text{start1-1} & \text{size1-4} & \text{last1-4} & \text{start2-3} & \text{size2-3} & \text{last2-5} & \text{height-4,} \\ \text{start1-3} & \text{size1-2} & \text{last1-4} & \text{start2-1} & \text{size2-2} & \text{last2-2} & \text{height-2,} \\ \text{start1-1} & \text{size1-2} & \text{last1-2} & \text{start2-1} & \text{size2-2} & \text{last2-2} & \text{height-3,} \\ \text{start1-4} & \text{size1-1} & \text{last1-4} & \text{start2-1} & \text{size2-1} & \text{last2-1} & \text{height-1} \end{array} \right\rangle, 4 \right)$ <p>Part (A) of Figure 5.173 shows the 4 parallelepipeds of height 4, 2, 3 and 1 associated with the items of the RECTANGLES collection (parallelepipeds since each rectangle also has a height). Part (B) gives the corresponding cumulated 2-dimensional profile, where each number is the cumulated height of all the rectangles that contain the corresponding region. The <code>cumulative_two_d</code> constraint holds since the highest peak of the cumulated 2-dimensional profile does not exceed the upper limit 4 imposed by the last argument of the <code>cumulative_two_d</code> constraint.</p>
Typical	<pre> RECTANGLES > 1 RECTANGLES.size1 > 0 RECTANGLES.size2 > 0 RECTANGLES.height > 0 LIMIT < sum(RECTANGLES.height)</pre>

Symmetries

- Items of RECTANGLES are [permutable](#).
- Attributes of RECTANGLES are [permutable](#) w.r.t. permutation (`start1, start2`) (`size1, size2`) (`last1, last2`) (`height`) (*permutation applied to all items*).
- RECTANGLES.height can be [decreased](#) to any value ≥ 0 .
- One and the same constant can be [added](#) to the `start1` and `last1` attributes of all items of RECTANGLES.
- One and the same constant can be [added](#) to the `start2` and `last2` attributes of all items of RECTANGLES.
- LIMIT can be [increased](#).

Usage

The `cumulative_two_d` constraint is a necessary condition for the `diffn` constraint in 3 dimensions (i.e., the placement of parallelepipeds in such a way that they do not pairwise overlap and that each parallelepiped has his sides parallel to the sides of the placement space).

Algorithm

A first natural way to handle this constraint would be to accumulate the [compulsory part](#) [223] of the different rectangles in a [quadtree](#) [333]. To each leave of the quadtree we associate the cumulated height of the rectangles containing the corresponding region.

Systems

[geost](#) in [Choco](#).

See also

related: `diffn` (`cumulative_two_d` is a necessary condition for `diffn`: forget one dimension when the number of dimensions is equal to 3).

specialisation: `bin_packing` (square of size 1 with a height replaced by task of duration 1), `cumulative` (rectangle with a height replaced by task with same height).

Keywords

characteristic of a constraint: derived collection.

constraint type: predefined constraint.

filtering: `quadtree`, `compulsory part`.

geometry: geometrical constraint.

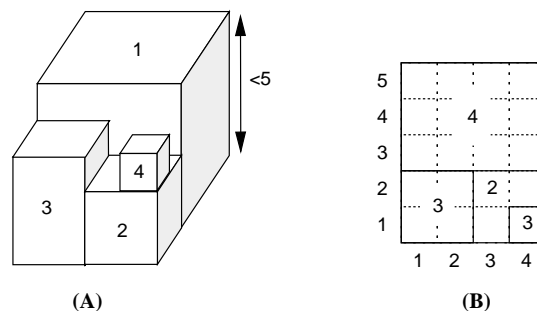


Figure 5.173: Two representations of a 2-dimensional cumulated profile