5.324 place_in_pyramid

DESCRIPTION LINKS GRAPH

Origin N. Beldiceanu

Constraint place_in_pyramid(ORTHOTOPES, VERTICAL_DIM)

Type ORTHOTOPE : collection(ori−dvar, siz−dvar, end−dvar)

Arguments

ORTHOTOPES : collection(orth − ORTHOTOPE)
VERTICAL_DIM : int

Restrictions

|ORTHOTOPE| > 0
require_at_least(2, ORTHOTOPE, [ori, siz, end])
ORTHOTOPE.siz ≥ 0
ORTHOTOPE.ori ≤ ORTHOTOPE.end
required(ORTHOTOPES, orth)
same_size(ORTHOTOPES, orth)
VERTICAL_DIM ≥ 1
diffn(ORTHOTOPES)

Purpose

For each pair of orthotopes (O_1, O_2) of the collection ORTHOTOPES, O_1 and O_2 do not overlap (two orthotopes do not overlap if there exists at least one dimension where their projections do not overlap). In addition, each orthotope of the collection ORTHOTOPES should be supported by one other orthotope or by the ground. The vertical dimension is given by the parameter VERTICAL_DIM.

Example

$$\left(\left\langle\begin{array}{l}
\texttt{orth}-\langle\texttt{ori}-1\ \texttt{siz}-3\ \texttt{end}-4, \texttt{ori}-1\ \texttt{siz}-2\ \texttt{end}-3\rangle,\\
\texttt{orth}-\langle\texttt{ori}-1\ \texttt{siz}-2\ \texttt{end}-3, \texttt{ori}-3\ \texttt{siz}-3\ \texttt{end}-6\rangle,\\
\texttt{orth}-\left\langle\begin{array}{lll}\texttt{ori}-5 & \texttt{siz}-6 & \texttt{end}-11,\\ \texttt{ori}-1 & \texttt{siz}-2 & \texttt{end}-3\end{array}\right\rangle,\\
\texttt{orth}-\langle\texttt{ori}-5\ \texttt{siz}-2\ \texttt{end}-7, \texttt{ori}-3\ \texttt{siz}-2\ \texttt{end}-5\rangle,\\
\texttt{orth}-\left\langle\begin{array}{lll}\texttt{ori}-8 & \texttt{siz}-3 & \texttt{end}-11,\\ \texttt{ori}-3 & \texttt{siz}-2 & \texttt{end}-5\end{array}\right\rangle,\\
\texttt{orth}-\left\langle\begin{array}{lll}\texttt{ori}-8 & \texttt{siz}-2 & \texttt{end}-10,\\ \texttt{ori}-5 & \texttt{siz}-2 & \texttt{end}-7\end{array}\right\rangle
\end{array}\right\rangle, 2\right)$$

Figure 5.671 depicts the placement associated with the example, where the i^{th} item of the ORTHOTOPES collection is represented by the rectangle Ri. The place_in_pyramid constraint holds since the rectangles do not overlap and since rectangles R1, R2, R3, R4, R5, and R6 are respectively supported by the ground, R1, the ground, R3, R3, and R5.

Typical

|ORTHOTOPE| > 1
ORTHOTOPE.siz > 0
|ORTHOTOPES| > 1

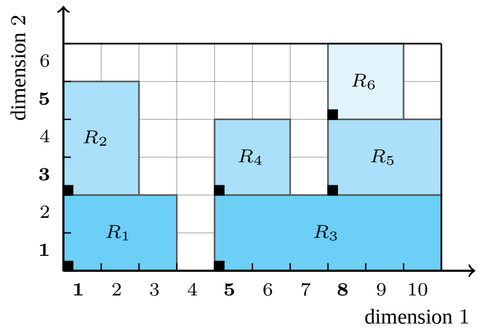


Figure 5.671: Solution corresponding to the **Example** slot

Symmetry Items of `ORTHOTOPES` are permutable.

Usage The `diffn` constraint is not enough if one wants to produce a placement where no orthotope floats in the air. This constraint is usually handled with a heuristic during the enumeration phase.

See also **used in graph description:** `orth_on_the_ground`, `orth_on_top_of_orth`.

Keywords **constraint type:** logic.

geometry: geometrical constraint, non-overlapping, orthotope.

Arc input(s) `ORTHOTOPES`

Arc generator $CLIQUE \mapsto \texttt{collection}(\texttt{orthotopes1}, \texttt{orthotopes2})$

Arc arity 2

Arc constraint(s)

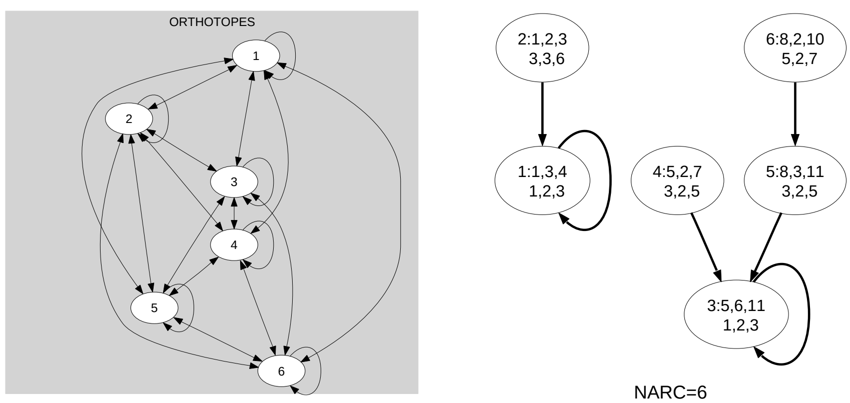
$$\bigvee \left(\begin{array}{l} \bigwedge \left(\begin{array}{l} \texttt{orthotopes1.key} = \texttt{orthotopes2.key}, \\ \texttt{orth\_on\_the\_ground}(\texttt{orthotopes1.orth}, \texttt{VERTICAL\_DIM}) \end{array} \right), \\ \bigwedge \left(\begin{array}{l} \texttt{orthotopes1.key} \neq \texttt{orthotopes2.key}, \\ \texttt{orth\_on\_top\_of\_orth} \left(\begin{array}{l} \texttt{orthotopes1.orth}, \\ \texttt{orthotopes2.orth}, \\ \texttt{VERTICAL\_DIM} \end{array} \right) \end{array} \right) \end{array} \right)$$

Graph property(ies) $\mathbf{NARC} = |\texttt{ORTHOTOPES}|$

Graph model The arc constraint of the graph constraint forces one of the following conditions:

- If the arc connects the same orthotope O then the ground directly supports O,
- Otherwise, if we have an arc from an orthotope O_1 to a distinct orthotope O_2, the condition is: O_1 is on top of O_2 (i.e., in all dimensions, except dimension `VERTICAL_DIM`, the projection of O_1 is included in the projection of O_2, while in dimension `VERTICAL_DIM` the projection of O_1 is located after the projection of O_2).

Parts (A) and (B) of Figure 5.672 respectively show the initial and final graph associated with the **Example** slot. Since we use the $\mathbf{NARC}$ graph property, the arcs of the final graph are stressed in bold.



(A) **(B)**

Figure 5.672: Initial and final graph of the `place_in_pyramid` constraint