5.80 covers_sboxes

DESCRIPTION LINKS LOGIC

Origin Geometry, derived from [305]

Constraint covers_sboxes(K, DIMS, OBJECTS, SBOXES)

Synonym covers.

Types

VARIABLES	:	collection(v−dvar)
INTEGERS	:	collection(v−int)
POSITIVES	:	collection(v−int)

Arguments

K	:	int
DIMS	:	sint
OBJECTS	:	collection(oid−int, sid−int, x − VARIABLES)
SBOXES	:	collection(sid−int, t − INTEGERS, l − POSITIVES)

Restrictions

required(VARIABLES, v)
|VARIABLES| = K
required(INTEGERS, v)
|INTEGERS| = K
required(POSITIVES, v)
|POSITIVES| = K
POSITIVES.v > 0
K > 0
DIMS ≥ 0
DIMS < K
required(OBJECTS, [oid, sid, x])
OBJECTS.oid ≥ 1
OBJECTS.oid ≤ |OBJECTS|
OBJECTS.sid ≥ 1
OBJECTS.sid ≤ |SBOXES|
required(SBOXES, [sid, t, l])
SBOXES.sid ≥ 1
SBOXES.sid ≤ |SBOXES|

Purpose

Holds if, for each pair of objects (O_i, O_j), $i < j$, O_i covers O_j with respect to a set of dimensions depicted by DIMS. O_i and O_j are objects that take a shape among a set of shapes. Each *shape* is defined as a finite set of shifted boxes, where each shifted box is described by a box in a K-dimensional space at a given offset (from the origin of the shape) with given sizes. More precisely, a *shifted box* is an entity defined by its shape id sid, shift offset t, and sizes l. Then, a shape is defined as the union of shifted boxes sharing the same shape id. An *object* is an entity defined by its unique object identifier oid, shape id sid and origin x.

An object O_i *covers* an object O_j with respect to a set of dimensions depicted by DIMS if and only if, for all shifted box s_j of O_j, there exists a shifted box s_i of O_i such that:

- For all dimensions $d \in$ DIMS, (1) the start of s_i in dimension d is less than or equal to the start of s_j in dimension d, and (2) the end of s_j in dimension d is less than or equal to the end of s_i in dimension d.
- There exists a dimension d where, (1) the start of s_i in dimension d coincide with the start of s_j in dimension d, or (2) the end of s_i in dimension d coincide with the end of s_j in dimension d.

Example

$$\left(\begin{array}{l} 2, \{0,1\}, \\ \left\langle\begin{array}{lll} \texttt{oid}-1 & \texttt{sid}-1 & \texttt{x}-\langle 1,1\rangle, \\ \texttt{oid}-2 & \texttt{sid}-2 & \texttt{x}-\langle 2,2\rangle, \\ \texttt{oid}-3 & \texttt{sid}-4 & \texttt{x}-\langle 2,3\rangle \end{array}\right\rangle, \\ \left\langle\begin{array}{lll} \texttt{sid}-1 & \texttt{t}-\langle 0,0\rangle & \texttt{l}-\langle 3,3\rangle, \\ \texttt{sid}-1 & \texttt{t}-\langle 3,0\rangle & \texttt{l}-\langle 2,2\rangle, \\ \texttt{sid}-2 & \texttt{t}-\langle 0,0\rangle & \texttt{l}-\langle 2,2\rangle, \\ \texttt{sid}-2 & \texttt{t}-\langle 2,0\rangle & \texttt{l}-\langle 1,1\rangle, \\ \texttt{sid}-3 & \texttt{t}-\langle 0,0\rangle & \texttt{l}-\langle 2,2\rangle, \\ \texttt{sid}-3 & \texttt{t}-\langle 2,1\rangle & \texttt{l}-\langle 1,1\rangle, \\ \texttt{sid}-4 & \texttt{t}-\langle 0,0\rangle & \texttt{l}-\langle 1,1\rangle \end{array}\right\rangle \end{array}\right)$$

Figure 5.162 shows the objects of the example. Since O_1 covers both O_2 and O_3, and since O_2 covers O_3, the covers_sboxes constraint holds.

Typical $|\text{OBJECTS}| > 1$

Symmetries

- Items of SBOXES are permutable.
- Items of OBJECTS.x, SBOXES.t and SBOXES.l are permutable (*same permutation used*).

Remark One of the eight relations of the *Region Connection Calculus* [305]. The constraint covers_sboxes is a relaxation of the original relation since it requires that each shifted box of an object is covered by one shifted box of the other object.

See also **common keyword:** contains_sboxes, coveredby_sboxes, disjoint_sboxes, equal_sboxes, inside_sboxes, meet_sboxes (*rcc8*), non_overlap_sboxes (*geometrical constraint*,*logic*), overlap_sboxes (*rcc8*).

Keywords **constraint type:** logic.

geometry: geometrical constraint, rcc8.

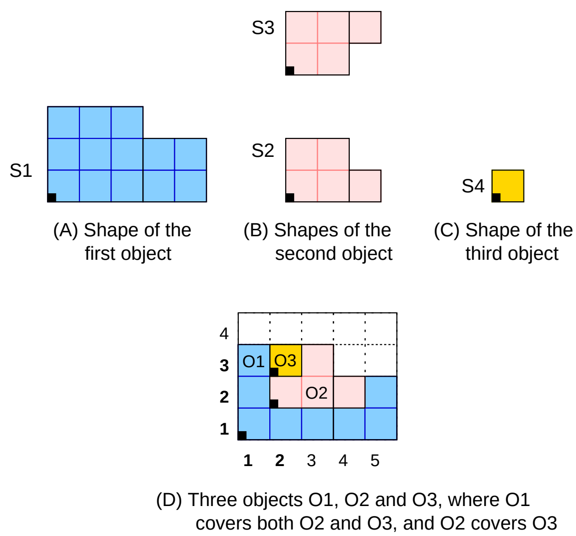

Figure 5.162: The three objects of the example

Logic

- $\texttt{origin}(\texttt{O1}, \texttt{S1}, \texttt{D}) \stackrel{\text{def}}{=} \texttt{O1.x}(\texttt{D}) + \texttt{S1.t}(\texttt{D})$
- $\texttt{end}(\texttt{O1}, \texttt{S1}, \texttt{D}) \stackrel{\text{def}}{=} \texttt{O1.x}(\texttt{D}) + \texttt{S1.t}(\texttt{D}) + \texttt{S1.l}(\texttt{D})$
- $\texttt{covers\_sboxes}(\texttt{Dims}, \texttt{O1}, \texttt{S1}, \texttt{O2}, \texttt{S2}) \stackrel{\text{def}}{=}$

$$\bigwedge \left(\begin{array}{l} \forall \texttt{D} \in \texttt{Dims} \\ \bigwedge \left(\begin{array}{l} \texttt{origin}(\texttt{O1}, \texttt{S1}, \texttt{D}) \leq \\ \texttt{origin}(\texttt{O2}, \texttt{S2}, \texttt{D}) \end{array}, \begin{array}{l} \texttt{end}(\texttt{O2}, \texttt{S2}, \texttt{D}) \leq \\ \texttt{end}(\texttt{O1}, \texttt{S1}, \texttt{D}) \end{array} \right), \\ \exists \texttt{D} \in \texttt{Dims} \\ \bigvee \left(\begin{array}{l} \texttt{origin}(\texttt{O1}, \texttt{S1}, \texttt{D}) = \\ \texttt{origin}(\texttt{O2}, \texttt{S2}, \texttt{D}) \end{array}, \begin{array}{l} \texttt{end}(\texttt{O1}, \texttt{S1}, \texttt{D}) = \\ \texttt{end}(\texttt{O2}, \texttt{S2}, \texttt{D}) \end{array} \right) \end{array} \right)$$

- $\texttt{covers\_objects}(\texttt{Dims}, \texttt{O1}, \texttt{O2}) \stackrel{\text{def}}{=}$

$$\begin{array}{l} \forall \texttt{S2} \in \texttt{sboxes}([\texttt{O2.sid}]) \\ \quad \exists \texttt{S1} \in \texttt{sboxes}\left(\left[\texttt{O1.sid} \right] \right) \\ \quad \texttt{covers\_sboxes}\left(\begin{array}{l} \texttt{Dims}, \\ \texttt{O1}, \\ \texttt{S1}, \\ \texttt{O2}, \\ \texttt{S2} \end{array} \right) \end{array}$$

- $\texttt{all\_covers}(\texttt{Dims}, \texttt{OIDS}) \stackrel{\text{def}}{=}$

$$\begin{array}{l} \forall \texttt{O1} \in \texttt{objects}(\texttt{OIDS}) \\ \quad \forall \texttt{O2} \in \texttt{objects}(\texttt{OIDS}) \\ \qquad \begin{array}{l} \texttt{O1.oid} < \\ \texttt{O2.oid} \end{array} \Rightarrow \\ \qquad \texttt{covers\_objects}\left(\begin{array}{l} \texttt{Dims}, \\ \texttt{O1}, \\ \texttt{O2} \end{array} \right) \end{array}$$

- $\texttt{all\_covers}(\texttt{DIMENSIONS}, \texttt{OIDS})$