5.144 element_sparse

DESCRIPTION LINKS GRAPH AUTOMATON

Origin CHIP

Constraint element_sparse(ITEM, TABLE, DEFAULT)

Usual name element

Arguments

ITEM	:	collection(index−dvar, value−dvar)
TABLE	:	collection(index−int, value−int)
DEFAULT	:	int

Restrictions

required(ITEM, [index, value])
ITEM.index ≥ 1
$|$ITEM$| = 1$
$|$TABLE$| > 0$
required(TABLE, [index, value])
TABLE.index ≥ 1
distinct(TABLE, index)

Purpose ITEM[1].value is equal to one of the entries of the table TABLE or to the default value DEFAULT if the entry ITEM[1].index does not exist in TABLE.

Example

$$\left(\begin{array}{l}\langle \texttt{index}-2\ \texttt{value}-5\rangle,\\ \left\langle\begin{array}{ll}\texttt{index}-1 & \texttt{value}-6,\\ \texttt{index}-2 & \texttt{value}-5,\\ \texttt{index}-4 & \texttt{value}-2,\\ \texttt{index}-8 & \texttt{value}-9\end{array}\right\rangle, 5\end{array}\right)$$

The element_sparse constraint holds since its first argument ITEM corresponds to the second item of the TABLE collection.

Typical

$|$TABLE$| > 1$
range(TABLE.value) > 1

Symmetries

- Items of TABLE are permutable.
- All occurrences of two distinct values in ITEM.value, TABLE.value or DEFAULT can be swapped; all occurrences of a value in ITEM.value, TABLE.value or DEFAULT can be renamed to any unused value.

Usage A sometimes more compact form of the element constraint: we are not obliged to specify explicitly the table entries that correspond to the specified default value. This can sometimes reduce drastically memory utilisation.

Remark The original constraint of CHIP had an additional parameter SIZE giving the maximum value of ITEM.index.

Reformulation Let I and V respectively denote ITEM[1].index and ITEM[1].value. The element_sparse(ITEM, TABLE, DEFAULT) constraint can be expressed in term of a reified constraint of the form:

$((\mathtt{I} = \mathtt{TABLE}[1].\mathtt{index} \wedge \mathtt{V} = \mathtt{TABLE}[1].\mathtt{value}) \vee$
$(\mathtt{I} = \mathtt{TABLE}[2].\mathtt{index} \wedge \mathtt{V} = \mathtt{TABLE}[2].\mathtt{value}) \vee$
$\ldots$
$(\mathtt{I} = \mathtt{TABLE}[|\mathtt{TABLE}|].\mathtt{index} \wedge \mathtt{V} = \mathtt{TABLE}[\mathtt{TABLE}|].\mathtt{value})) \quad \vee$
$((\mathtt{I} \neq \mathtt{TABLE}[1].\mathtt{index}) \wedge$
$(\mathtt{I} \neq \mathtt{TABLE}[2].\mathtt{index}) \wedge$
$\ldots$
$(\mathtt{I} \neq \mathtt{TABLE}[|\mathtt{TABLE}|].\mathtt{index}) \wedge$
$(\mathtt{V} = \mathtt{DEFAULT}))$.

See also **common keyword:** elem, element *(array constraint)*, elements_sparse *(sparse table)*.

implies: elements_sparse.

system of constraints: elements_sparse.

Keywords **characteristic of a constraint:** automaton, automaton without counters, reified automaton constraint, derived collection.

constraint arguments: binary constraint.

constraint network structure: centered cyclic(2) constraint network(1).

constraint type: data constraint.

filtering: arc-consistency.

modelling: array constraint, table, sparse table, sparse functional dependency, variable indexing.

Derived Collections

$$\text{col}\left(\begin{array}{l}\texttt{DEF}-\texttt{collection}(\texttt{index}-\texttt{int},\texttt{value}-\texttt{int}),\\ [\texttt{item}(\texttt{index}-0,\texttt{value}-\texttt{DEFAULT})]\end{array}\right)$$

$$\text{col}\left(\begin{array}{l}\texttt{TABLE\_DEF}-\texttt{collection}(\texttt{index}-\texttt{dvar},\texttt{value}-\texttt{dvar}),\\ \left[\begin{array}{l}\texttt{item}(\texttt{index}-\texttt{TABLE.index},\texttt{value}-\texttt{TABLE.value}),\\ \texttt{item}(\texttt{index}-\texttt{DEF.index},\texttt{value}-\texttt{DEF.value})\end{array}\right]\end{array}\right)$$

Arc input(s) ITEM TABLE_DEF

Arc generator $PRODUCT \mapsto$ collection(item, table_def)

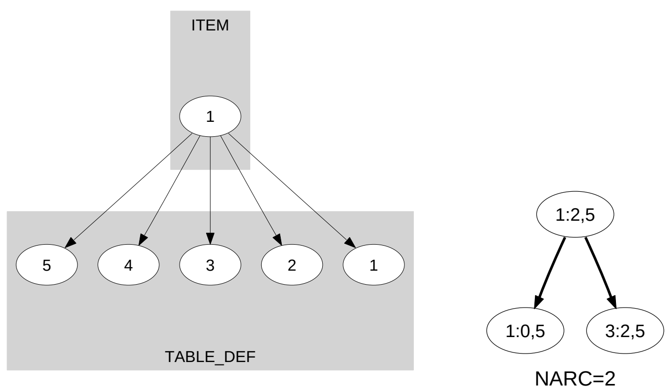
Arc arity 2

Arc constraint(s)
- $\texttt{item.value} = \texttt{table\_def.value}$
- $\texttt{item.index} = \texttt{table\_def.index} \vee \texttt{table\_def.index} = 0$

Graph property(ies) $\mathbf{NARC} \geq 1$

Graph model The final graph has between one and two arc constraints: it has two arcs when the default value DEFAULT occurs also in the table TABLE; otherwise it has only one arc.

Parts (A) and (B) of Figure 5.315 respectively show the initial and final graph associated with the **Example** slot. Since we use the **NARC** graph property the arcs of the final graph are outline with thick lines.



(A) **(B)**

Figure 5.315: Initial and final graph of the element_sparse constraint

Automaton Figure 5.316 depicts the automaton associated with the `element_sparse` constraint. Let `INDEX` and `VALUE` respectively be the `index` and the `value` attributes of the unique item of the `ITEM` collection. Let $\texttt{INDEX}_i$ and $\texttt{VALUE}_i$ respectively be the `index` and the `value` attributes of the i^{th} item of the `TABLE` collection. To each quintuple $(\texttt{INDEX}, \texttt{VALUE}, \texttt{DEFAULT}, \texttt{INDEX}_i, \texttt{VALUE}_i)$ corresponds a signature variable S_i as well as the following signature constraint:

$$\begin{cases} (\texttt{INDEX} \neq \texttt{INDEX}_i \ \wedge \texttt{VALUE} \neq \texttt{DEFAULT}) & \Leftrightarrow \quad S_i = 0 \quad \wedge \\ (\texttt{INDEX} = \texttt{INDEX}_i \ \wedge \texttt{VALUE} = \texttt{VALUE}_i \quad) & \Leftrightarrow \quad S_i = 1 \quad \wedge \\ (\texttt{INDEX} \neq \texttt{INDEX}_i \ \wedge \texttt{VALUE} = \texttt{DEFAULT}) & \Leftrightarrow \quad S_i = 2 \end{cases} .$$

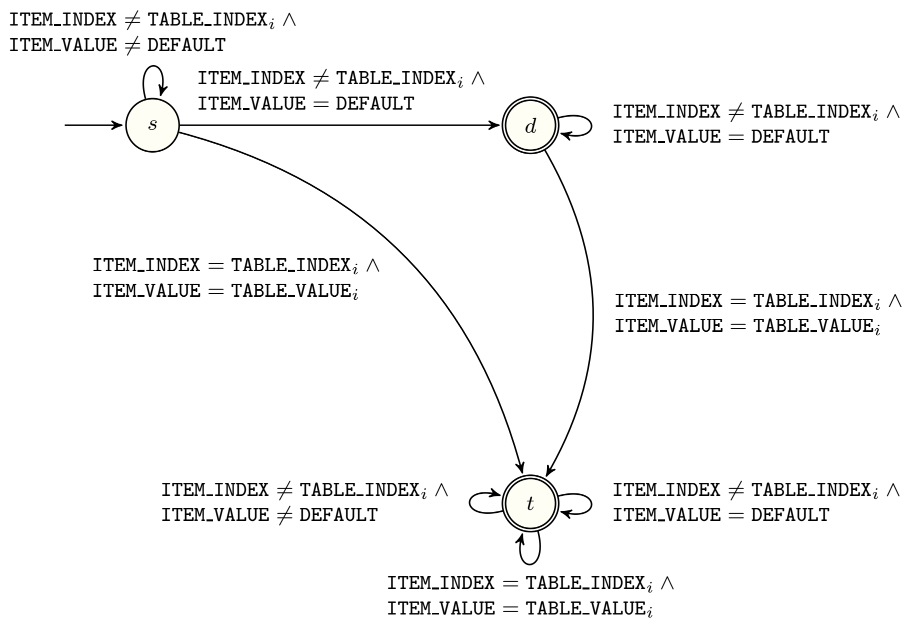


Figure 5.316: Automaton of the `element_sparse` constraint

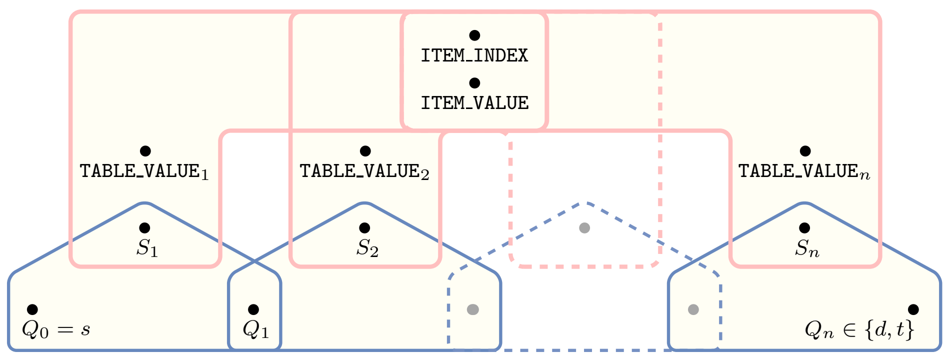


Figure 5.317: Hypergraph of the reformulation corresponding to the automaton of the `element_sparse` constraint