5.276 next_element

DESCRIPTION LINKS GRAPH AUTOMATON

Origin

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Constraint

next_element(THRESHOLD, INDEX, TABLE, VAL)

Arguments

THRESHOLD	:	dvar
INDEX	:	dvar
TABLE	:	collection(index−int, value−dvar)
VAL	:	dvar

Restrictions

INDEX ≥ 1
INDEX $\leq$ |TABLE|
THRESHOLD $<$ INDEX
required(TABLE, [index, value])
|TABLE| > 0
TABLE.index ≥ 1
TABLE.index $\leq$ |TABLE|
distinct(TABLE, index)

Purpose

INDEX is the smallest entry of TABLE strictly greater than THRESHOLD containing value VAL.

Example

$$\left(2, 3, \left\langle \begin{array}{ll} \texttt{index}-1 & \texttt{value}-1, \\ \texttt{index}-2 & \texttt{value}-8, \\ \texttt{index}-3 & \texttt{value}-9, \\ \texttt{index}-4 & \texttt{value}-5, \\ \texttt{index}-5 & \texttt{value}-9 \end{array} \right\rangle, 9\right)$$

The next_element constraint holds since 3 is the smallest entry located after entry 2 that contains value 9.

Typical

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

Usage

Originally introduced for modelling the fact that a nucleotide has to be consumed as soon as possible at cycle INDEX after a given cycle represented by variable THRESHOLD.

See also

related: minimum_greater_than *(identify an element in a table)*, next_greater_element *(allow to iterate over the values of a table)*.

Keywords

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

constraint network structure: centered cyclic(3) constraint network(1).

constraint type: data constraint.

modelling: table.

Derived Collection

$$\texttt{col}\left(\begin{array}{l}\texttt{ITEM}-\texttt{collection}(\texttt{index}-\texttt{dvar},\texttt{value}-\texttt{dvar}),\\ [\texttt{item}(\texttt{index}-\texttt{THRESHOLD},\texttt{value}-\texttt{VAL})]\end{array}\right)$$

Arc input(s) ITEM TABLE

Arc generator $PRODUCT \mapsto \texttt{collection}(\texttt{item},\texttt{table})$

Arc arity 2

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

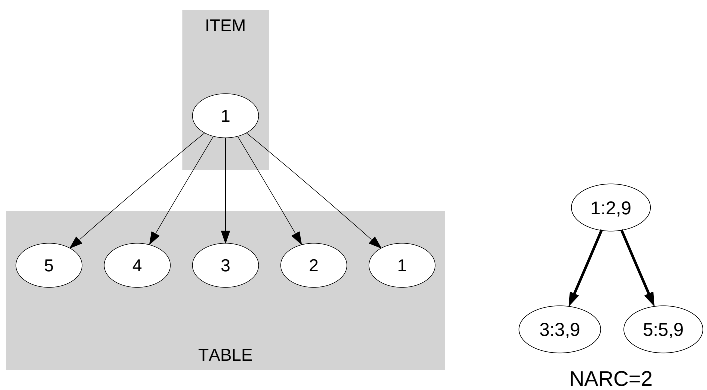
Graph property(ies) $\mathbf{NARC} > 0$

Sets

$$\mathsf{SUCC} \mapsto \left[\begin{array}{l}\texttt{source},\\ \texttt{variables}-\texttt{col}\left(\begin{array}{l}\texttt{VARIABLES}-\texttt{collection}(\texttt{var}-\texttt{dvar}),\\ [\texttt{item}(\texttt{var}-\texttt{TABLE.index})]\end{array}\right)\end{array}\right]$$

Constraint(s) on sets $\texttt{minimum}(\texttt{INDEX},\texttt{variables})$

Graph model Parts (A) and (B) of Figure 5.594 respectively show the initial and final graph associated with the second graph constraint of the **Example** slot. Since we use the **NARC** graph property, the arcs of the final graph are stressed in bold.



(A) **(B)**

Figure 5.594: Initial and final graph of the next_element constraint

Automaton Figure 5.595 depicts the automaton associated with the next_element constraint. Let $\mathtt{I}_k$ and $\mathtt{V}_k$ respectively be the index and the value attributes of the k^{th} item of the TABLE collections. To each quintuple $(\mathtt{THRESHOLD}, \mathtt{INDEX}, \mathtt{VAL}, \mathtt{I}_k, \mathtt{V}_k)$ corresponds a signature variable S_k as well as the following signature constraint:

$$((\mathtt{I}_k \leq \mathtt{THRESHOLD}) \wedge (\mathtt{I}_k < \mathtt{INDEX}) \wedge (\mathtt{V}_k = \mathtt{VAL})) \Leftrightarrow S_k = 0 \wedge$$
$$((\mathtt{I}_k \leq \mathtt{THRESHOLD}) \wedge (\mathtt{I}_k < \mathtt{INDEX}) \wedge (\mathtt{V}_k \neq \mathtt{VAL})) \Leftrightarrow S_k = 1 \wedge$$
$$((\mathtt{I}_k \leq \mathtt{THRESHOLD}) \wedge (\mathtt{I}_k = \mathtt{INDEX}) \wedge (\mathtt{V}_k = \mathtt{VAL})) \Leftrightarrow S_k = 2 \wedge$$
$$((\mathtt{I}_k \leq \mathtt{THRESHOLD}) \wedge (\mathtt{I}_k = \mathtt{INDEX}) \wedge (\mathtt{V}_k \neq \mathtt{VAL})) \Leftrightarrow S_k = 3 \wedge$$
$$((\mathtt{I}_k \leq \mathtt{THRESHOLD}) \wedge (\mathtt{I}_k > \mathtt{INDEX}) \wedge (\mathtt{V}_k = \mathtt{VAL})) \Leftrightarrow S_k = 4 \wedge$$
$$((\mathtt{I}_k \leq \mathtt{THRESHOLD}) \wedge (\mathtt{I}_k > \mathtt{INDEX}) \wedge (\mathtt{V}_k \neq \mathtt{VAL})) \Leftrightarrow S_k = 5 \wedge$$
$$((\mathtt{I}_k > \mathtt{THRESHOLD}) \wedge (\mathtt{I}_k < \mathtt{INDEX}) \wedge (\mathtt{V}_k = \mathtt{VAL})) \Leftrightarrow S_k = 6 \wedge$$
$$((\mathtt{I}_k > \mathtt{THRESHOLD}) \wedge (\mathtt{I}_k < \mathtt{INDEX}) \wedge (\mathtt{V}_k \neq \mathtt{VAL})) \Leftrightarrow S_k = 7 \wedge$$
$$((\mathtt{I}_k > \mathtt{THRESHOLD}) \wedge (\mathtt{I}_k = \mathtt{INDEX}) \wedge (\mathtt{V}_k = \mathtt{VAL})) \Leftrightarrow S_k = 8 \wedge$$
$$((\mathtt{I}_k > \mathtt{THRESHOLD}) \wedge (\mathtt{I}_k = \mathtt{INDEX}) \wedge (\mathtt{V}_k \neq \mathtt{VAL})) \Leftrightarrow S_k = 9 \wedge$$
$$((\mathtt{I}_k > \mathtt{THRESHOLD}) \wedge (\mathtt{I}_k > \mathtt{INDEX}) \wedge (\mathtt{V}_k = \mathtt{VAL})) \Leftrightarrow S_k = 10 \wedge$$
$$((\mathtt{I}_k > \mathtt{THRESHOLD}) \wedge (\mathtt{I}_k > \mathtt{INDEX}) \wedge (\mathtt{V}_k \neq \mathtt{VAL})) \Leftrightarrow S_k = 11.$$

The automaton is constructed in order to fulfil the following conditions:

- We look for an item of the TABLE collection such that $\mathtt{INDEX}_i > \mathtt{THRESHOLD}$ and $\mathtt{INDEX}_i = \mathtt{INDEX}$ and $\mathtt{VALUE}_i = \mathtt{VAL}$,
- There should not exist any item of the TABLE collection such that $\mathtt{INDEX}_i > \mathtt{THRESHOLD}$ and $\mathtt{INDEX}_i < \mathtt{INDEX}$ and $\mathtt{VALUE}_i = \mathtt{VAL}$.

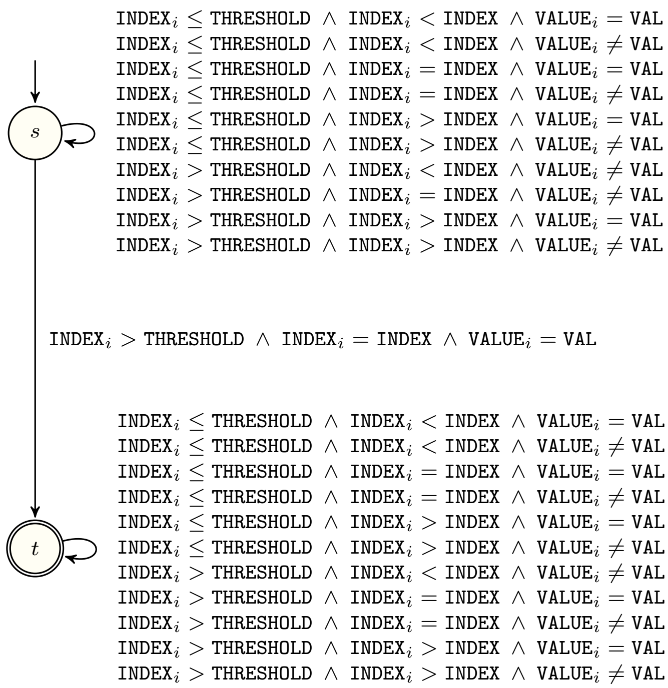


Figure 5.595: Automaton of the `next_element` constraint

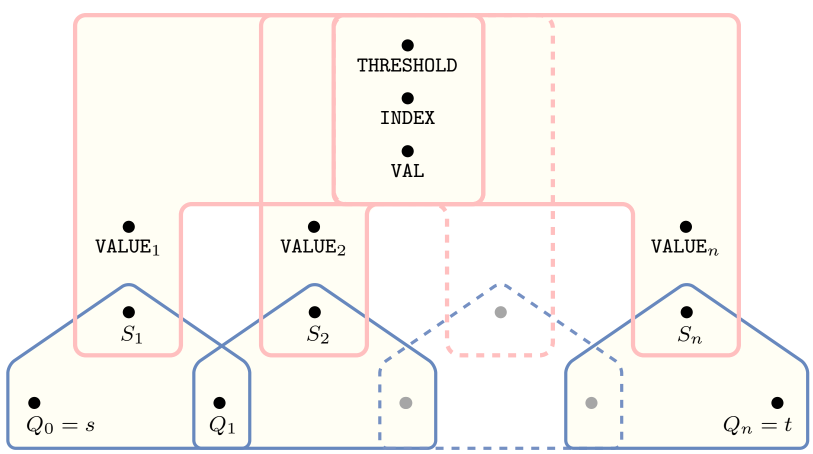


Figure 5.596: Hypergraph of the reformulation corresponding to the automaton of the `next_element` constraint