5.157 full_group

DESCRIPTION LINKS AUTOMATON

Origin Inspired by group

Constraint

$$\texttt{full\_group}\left(\begin{array}{l}\texttt{NGROUP},\\ \texttt{MIN\_SIZE},\\ \texttt{MAX\_SIZE},\\ \texttt{MIN\_DIST},\\ \texttt{MAX\_DIST},\\ \texttt{NVAL},\\ \texttt{VARIABLES},\\ \texttt{VALUES}\end{array}\right)$$

Synonym group_without_border.

Arguments

NGROUP	:	dvar
MIN_SIZE	:	dvar
MAX_SIZE	:	dvar
MIN_DIST	:	dvar
MAX_DIST	:	dvar
NVAL	:	dvar
VARIABLES	:	collection(var−dvar)
VALUES	:	collection(val−int)

Restrictions

$\texttt{NGROUP} \geq 0$
$\texttt{MIN\_SIZE} \geq 0$
$\texttt{MAX\_SIZE} \geq \texttt{MIN\_SIZE}$
$\texttt{MIN\_DIST} \geq 0$
$\texttt{MAX\_DIST} \geq \texttt{MIN\_DIST}$
$\texttt{MAX\_DIST} \leq |\texttt{VARIABLES}| - 2$
$\texttt{NVAL} \geq \texttt{MAX\_SIZE}$
$\texttt{NVAL} \geq \texttt{NGROUP}$
$\texttt{NVAL} \leq |\texttt{VARIABLES}| - 2$
required(VARIABLES, var)
required(VALUES, val)
distinct(VALUES, val)

Purpose

Let n be the number of variables of the collection VARIABLES. Let $X_i, X_{i+1}, \ldots, X_j$ $(1 \leq i \leq j \leq n)$ be consecutive variables of the collection of variables VARIABLES such that all the following conditions simultaneously apply:

- All variables $X_i, \ldots, X_j$ take their value in the set of values VALUES,
- $i = 1$ or X_{i-1} does not take a value in VALUES,
- $j = n$ or X_{j+1} does not take a value in VALUES.

We call such a sequence of variables a *group*. A *full group* is a group that neither starts at position 1 nor ends at position n. Similarly an *anti-full group* is a maximum sequence of variables that are not assigned any value from VALUES that neither starts at position 1 nor ends at position n.
The constraint full_group is true if all the following conditions hold:

- There are exactly NGROUP full groups of variables,
- MIN_SIZE is the number of variables of the smallest full group,
- MAX_SIZE is the number of variables of the largest full group,
- MIN_DIST is the number of variables of the smallest anti-full group,
- MAX_DIST is the number of variables of the largest anti-full group,
- NVAL is the number of variables that belong to a full group.

Example

$(2, 2, 3, 1, 1, 5, \langle 0, 1, 2, 6, 2, 7, 4, 8, 9\rangle, \langle 0, 2, 4, 6, 8\rangle)$

Given the fact that full groups are formed by even values in $\{0, 2, 4, 6, 8\}$ (i.e., values expressed by the VALUES collection), the full_group constraint holds since:

- Its first argument, NGROUP, is set to value 2 since the sequence 0 1 2 6 2 7 4 8 9 contains two full groups of even values (i.e., group 2 6 2 and group 4 8). Note that the first 0 is not a full group since it is located at the first position of the sequence.
- Its second argument, MIN_SIZE, is set to value 2 since the smallest full group of even values involves only two elements (i.e., the full group 4 8).
- Its third argument, MAX_SIZE, is set to value 3 since the largest full group of even values involves three elements (i.e., the full group 2 6 2).
- Its fourth argument, MIN_DIST, is set to value 1 since the smallest anti-full groups involve a single element (i.e., the anti-full groups 1 and 7).
- Its fifth argument, MAX_DIST, is set to value 1 since the largest anti-full groups involve a single element (i.e., the anti-full groups 1 and 7).
- Its sixth argument, NVAL, is set to value 5 since the total number of even values part of a full group of the sequence 0 1 2 6 2 7 4 8 9 is equal to 5 (i.e., elements 2, 6, 2, 4 and 8).

Typical

$\mathtt{NGROUP} > 0$
$\mathtt{MIN\_SIZE} > 0$
$\mathtt{MAX\_SIZE} > \mathtt{MIN\_SIZE}$
$\mathtt{MIN\_DIST} > 0$
$\mathtt{MAX\_DIST} > \mathtt{MIN\_DIST}$
$\mathtt{MAX\_DIST} < |\mathtt{VARIABLES}|$
$\mathtt{NVAL} > \mathtt{MAX\_SIZE}$
$\mathtt{NVAL} > \mathtt{NGROUP}$
$\mathtt{NVAL} < |\mathtt{VARIABLES}|$
$|\mathtt{VARIABLES}| > 1$
$\mathtt{range}(\mathtt{VARIABLES.var}) > 1$
$|\mathtt{VALUES}| > 0$
$|\mathtt{VARIABLES}| > |\mathtt{VALUES}|$

Symmetries

- Items of VARIABLES can be reversed.
- Items of VALUES are permutable.
- An occurrence of a value of VARIABLES.var that belongs to VALUES.val (resp. does not belong to VALUES.val) can be replaced by any other value in VALUES.val (resp. not in VALUES.val).

Arg. properties

- Functional dependency: NGROUP determined by VARIABLES and VALUES.
- Functional dependency: MIN_SIZE determined by VARIABLES and VALUES.
- Functional dependency: MAX_SIZE determined by VARIABLES and VALUES.
- Functional dependency: MIN_DIST determined by VARIABLES and VALUES.
- Functional dependency: MAX_DIST determined by VARIABLES and VALUES.
- Functional dependency: NVAL determined by VARIABLES and VALUES.

See also

common keyword: group *(timetabling constraint,sequence)*.

Keywords

characteristic of a constraint: automaton, automaton with counters, automaton with same input symbol.

combinatorial object: sequence.

constraint arguments: reverse of a constraint, pure functional dependency.

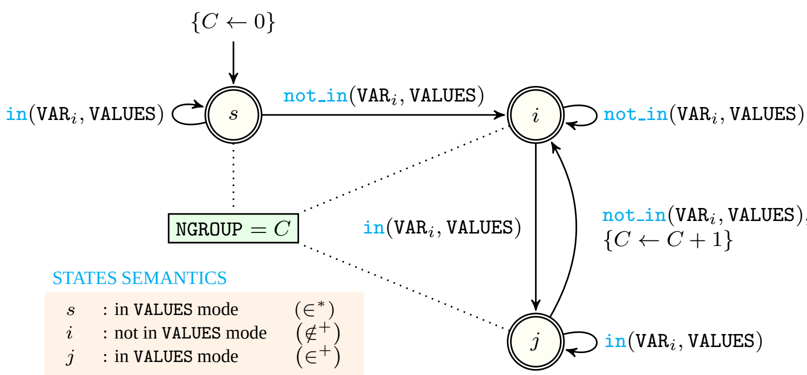
constraint network structure: alpha-acyclic constraint network(2), alpha-acyclic constraint network(3).

constraint type: timetabling constraint.

filtering: glue matrix.

modelling: functional dependency.

Automaton Figures 5.354, 5.356, 5.358, 5.360, 5.362 and 5.364 depict the different automata associated with the `full_group` constraint. For the automata that respectively compute `NGROUP`, `MIN_SIZE`, `MAX_SIZE`, `MIN_DIST`, `MAX_DIST` and `NVAL` we have a 0-1 signature variable $\mathtt{S}_i$ for each variable $\mathtt{VAR}_i$ of the collection `VARIABLES`. The following signature constraint links $\mathtt{VAR}_i$ and $\mathtt{S}_i$: $\mathtt{VAR}_i \in \mathtt{VALUES} \Leftrightarrow \mathtt{S}_i$.



Glue matrix where $\overrightarrow{C}$ and $\overleftarrow{C}$ resp. represent the counter value C at the end of a prefix and at the end of the corresponding reverse suffix that partitions the sequence `VARIABLES`.

	$s\,(\in^*)$	$i\,(\notin^+)$	$j\,(\in^+)$
$s(\in^*)$	0	$\overleftarrow{C}$	$\overleftarrow{C}$
$i(\notin^+)$	$\overrightarrow{C}$	$\overrightarrow{C}+\overleftarrow{C}$	$\overrightarrow{C}+1+\overleftarrow{C}$
$j(\in^+)$	$\overrightarrow{C}$	$\overrightarrow{C}+1+\overleftarrow{C}$	$\overrightarrow{C}+1+\overleftarrow{C}$

Figure 5.354: Automaton for the `NGROUP` argument of the `full_group` constraint and its glue matrix

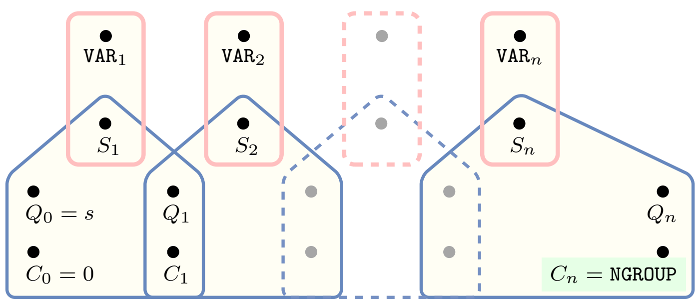


Figure 5.355: Hypergraph of the reformulation corresponding to the automaton (with one counter) of the `NGROUP` argument of the `full_group` constraint (since all states of the automaton are accepting there is no restriction on the last variable Q_n)

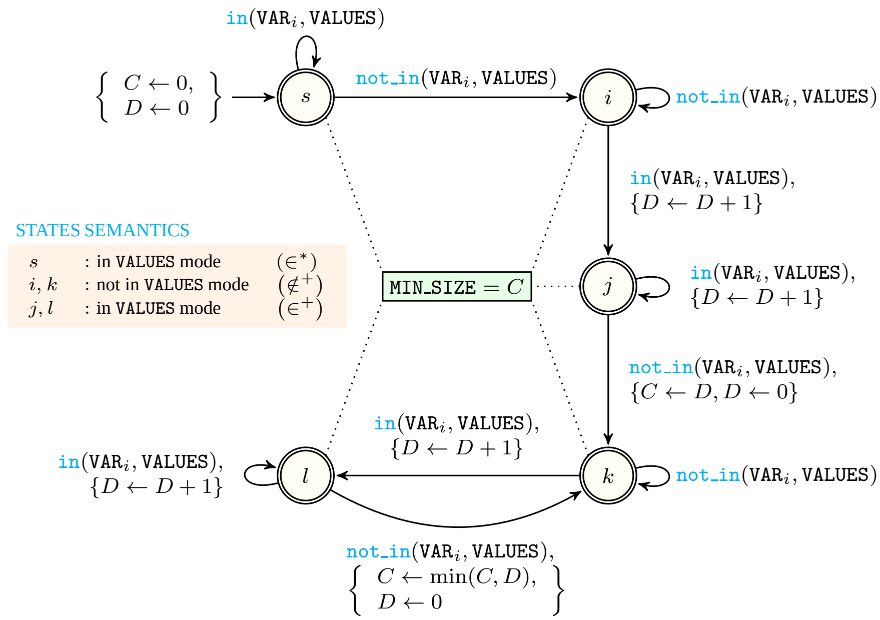


Figure 5.356: Automaton for the MIN_SIZE argument of the full_group constraint

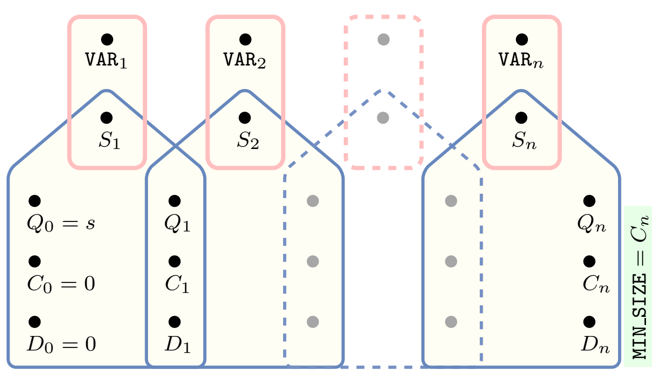
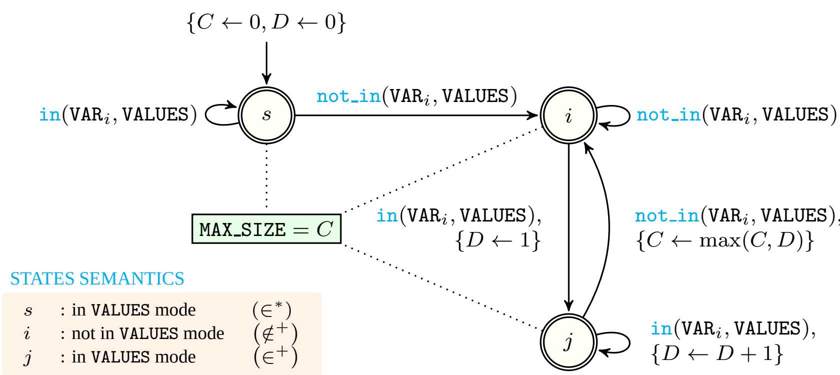


Figure 5.357: Hypergraph of the reformulation corresponding to the automaton (with two counters) of the MIN_SIZE argument of the full_group constraint (since all states of the automaton are accepting there is no restriction on the last variable Q_n)



Glue matrix where $\overrightarrow{C}$, $\overrightarrow{D}$ and $\overleftarrow{C}$, $\overleftarrow{D}$ resp. represent the counter value C, D at the end of a prefix and at the end of the corresponding reverse suffix that partitions the sequence VARIABLES.

	$s\ (\in^*)$	$i\ (\notin^+)$	$j\ (\in^+)$
$s(\in^*)$	0	$\overleftarrow{C}$	$\overleftarrow{C}$
$i(\notin^+)$	$\overrightarrow{C}$	$\max(\overrightarrow{C}, \overleftarrow{C})$	$\max(\overrightarrow{C}, \overleftarrow{D}, \overleftarrow{C})$
$j(\in^+)$	$\overrightarrow{C}$	$\max(\overrightarrow{C}, \overrightarrow{D}, \overleftarrow{C})$	$\max(\overrightarrow{C}, \overrightarrow{D} + \overleftarrow{D}, \overleftarrow{C})$

Figure 5.358: Automaton for the MAX_SIZE argument of the full_group constraint and its glue matrix

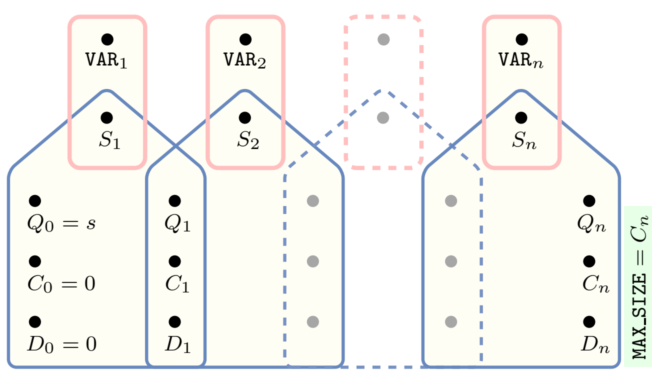


Figure 5.359: Hypergraph of the reformulation corresponding to the automaton (with two counters) of the MAX_SIZE argument of the full_group constraint (since all states of the automaton are accepting there is no restriction on the last variable Q_n)

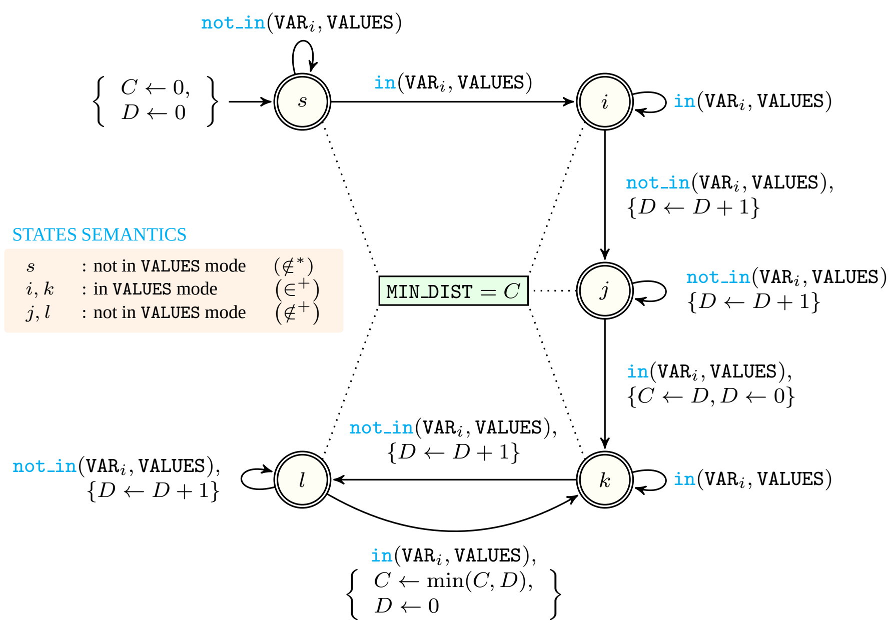


Figure 5.360: Automaton for the MIN_DIST argument of the full_group constraint

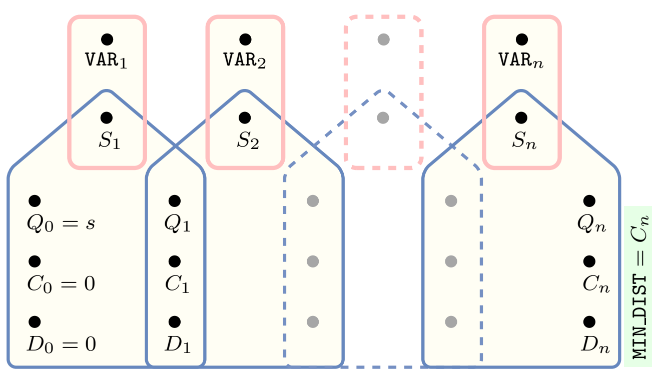
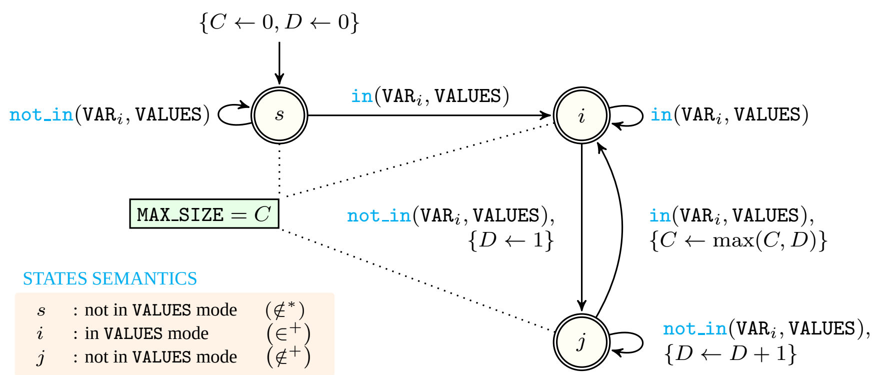


Figure 5.361: Hypergraph of the reformulation corresponding to the automaton (with two counters) of the MIN_DIST argument of the full_group constraint (since all states of the automaton are accepting there is no restriction on the last variable Q_n)



Glue matrix where $\overrightarrow{C}$, $\overrightarrow{D}$ and $\overleftarrow{C}$, $\overleftarrow{D}$ resp. represent the counter value C, D at the end of a prefix and at the end of the corresponding reverse suffix that partitions the sequence VARIABLES.

	$s\ (\notin^*)$	$i\ (\in^+)$	$j\ (\notin^+)$
$s(\notin^*)$	0	$\overleftarrow{C}$	$\overleftarrow{C}$
$i(\in^+)$	$\overrightarrow{C}$	$\max(\overrightarrow{C}, \overleftarrow{C})$	$\max(\overrightarrow{C}, \overleftarrow{D}, \overleftarrow{C})$
$j(\notin^+)$	$\overrightarrow{C}$	$\max(\overrightarrow{C}, \overrightarrow{D}, \overleftarrow{C})$	$\max(\overrightarrow{C}, \overrightarrow{D} + \overleftarrow{D}, \overleftarrow{C})$

Figure 5.362: Automaton for the MAX_DIST argument of the full_group constraint and its glue matrix

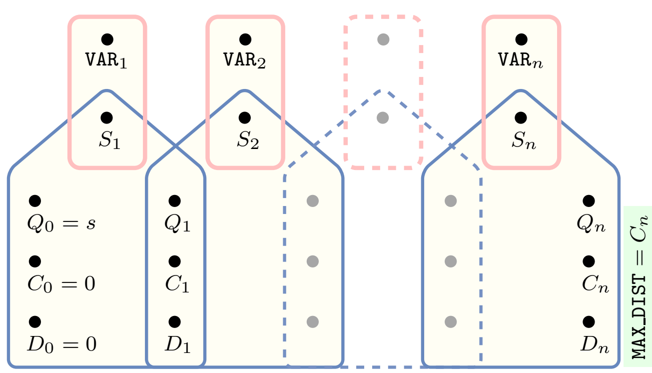
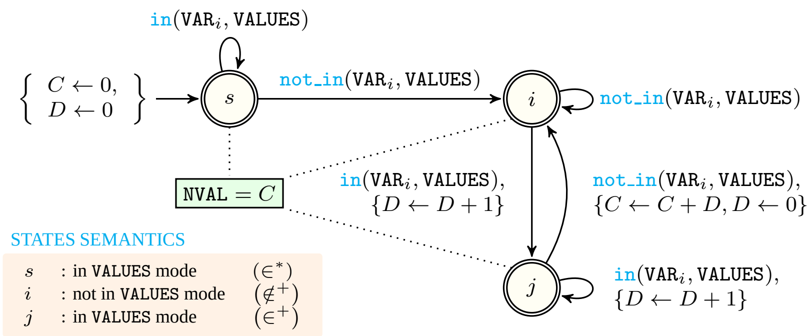


Figure 5.363: Hypergraph of the reformulation corresponding to the automaton (with two counters) of the MAX_DIST argument of the full_group constraint (since all states of the automaton are accepting there is no restriction on the last variable Q_n)



Glue matrix where $\overrightarrow{C}$ and $\overleftarrow{C}$ resp. represent the counter value C at the end of a prefix and at the end of the corresponding reverse suffix that partitions the sequence VARIABLES.

	$s\ (\in^*)$	$i\ (\notin^+)$	$j\ (\in^+)$
$s(\in^*)$	0	$\overleftarrow{C}$	$\overleftarrow{C}$
$i(\notin^+)$	$\overrightarrow{C}$	$\overrightarrow{C}+\overleftarrow{C}$	$\overrightarrow{C}+\overleftarrow{D}+\overleftarrow{C}$
$j(\in^+)$	$\overrightarrow{C}$	$\overrightarrow{C}+\overrightarrow{D}+\overleftarrow{C}$	$\overrightarrow{C}+\overrightarrow{D}+\overleftarrow{D}+\overleftarrow{C}$

Figure 5.364: Automaton for the NVAL argument of the full_group constraint and its glue matrix

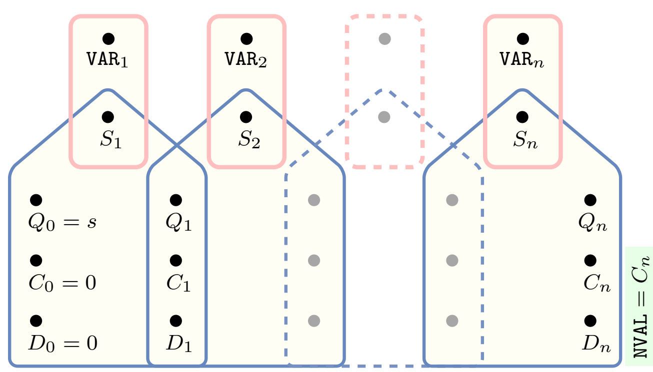


Figure 5.365: Hypergraph of the reformulation corresponding to the automaton (with two counters) of the NVAL argument of the full_group constraint (since all states of the automaton are accepting there is no restriction on the last variable Q_n)