## 5.113 deepest_valley

DESCRIPTION LINKS AUTOMATON

**Origin** Derived from `valley`.

**Constraint** `deepest_valley(DEPTH, VARIABLES)`

**Arguments**

| | | |
|---|---|---|
| DEPTH | : | dvar |
| VARIABLES | : | collection(var−dvar) |

**Restriction** `required(VARIABLES, var)`

**Purpose** A variable $V_k$ $(1 < k < m)$ of the sequence of variables VARIABLES $= V_1, \ldots, V_m$ is a *valley* if and only if there exists an $i$ $(1 < i \leq k)$ such that $V_{i-1} > V_i$ and $V_i = V_{i+1} = \cdots = V_k$ and $V_k < V_{k+1}$. DEPTH is the minimum value of the valley variables. If no such variable exists DEPTH is equal to the default value MAXINT.

**Example**

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

The first `deepest_valley` constraint holds since 2 is the deepest valley of the sequence 5 3 4 8 8 2 7 1.

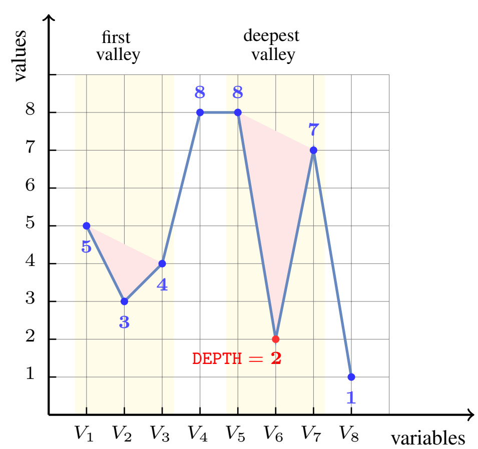



Figure 5.251: Illustration of the first example of the **Example** slot: a sequence of eight variables $V_1$, $V_2$, $V_3$, $V_4$, $V_5$, $V_6$, $V_7$, $V_8$ respectively fixed to values 5, 3, 4, 8, 8, 2, 7, 1 and its corresponding deepest valley of depth 2

**Typical**

$|\texttt{VARIABLES}| > 2$
$\texttt{range}(\texttt{VARIABLES.var}) > 2$
$\texttt{valley}(\texttt{VARIABLES.var}) > 0$

**Symmetry**

Items of VARIABLES can be reversed.

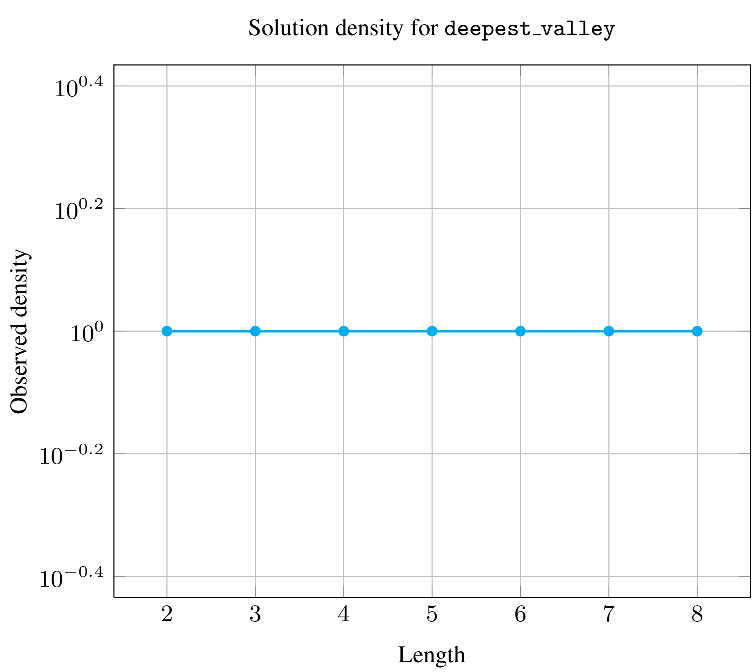
**Arg. properties**

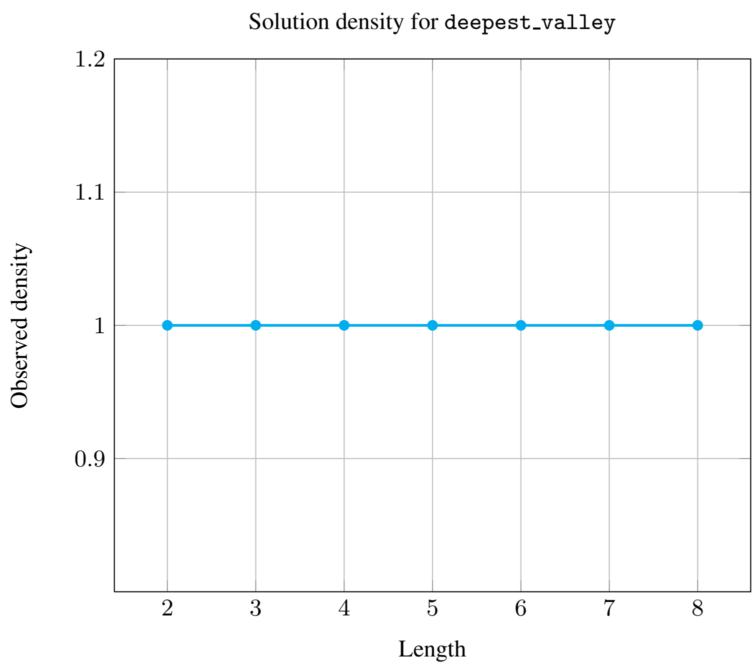
Functional dependency: DEPTH determined by VARIABLES.

**Counting**

| Length ($n$) | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| Solutions | 9 | 64 | 625 | 7776 | 117649 | 2097152 | 43046721 |

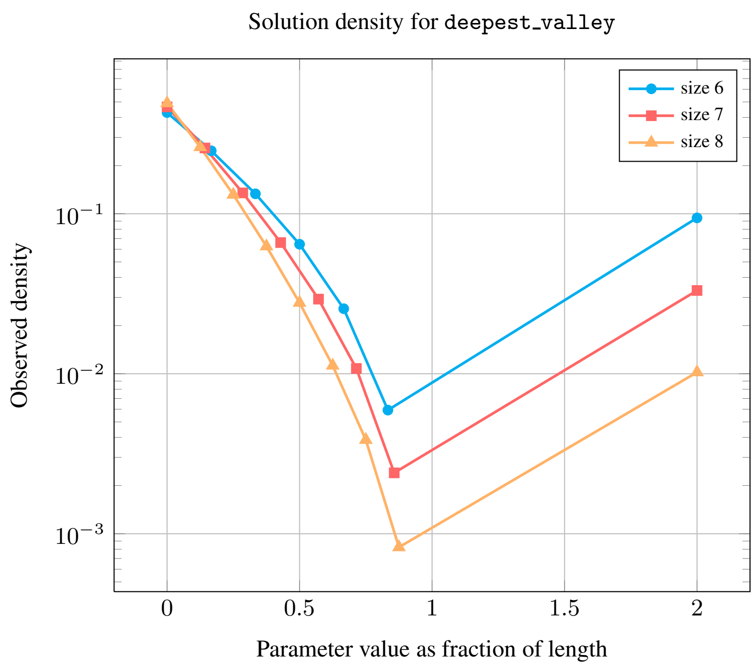
Number of solutions for deepest_valley: domains $0..n$

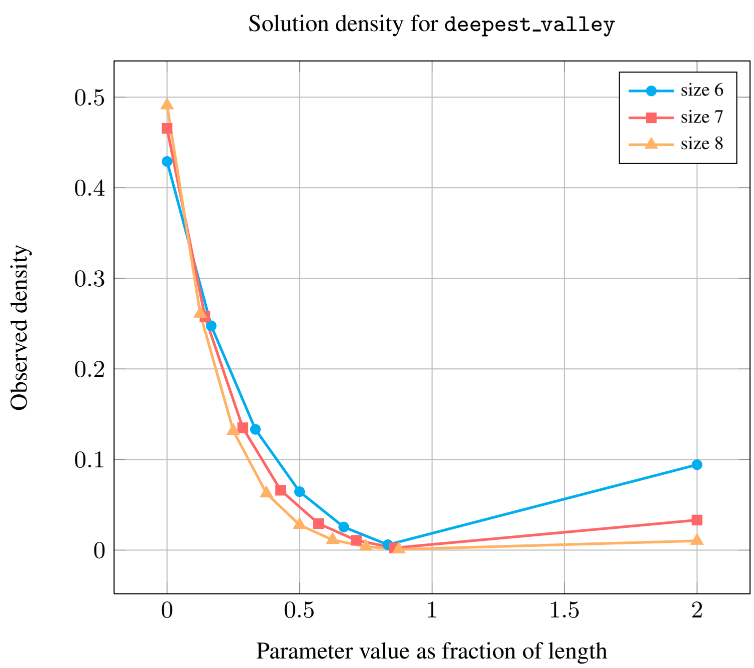





| Length ($n$) | | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Total | | 9 | 64 | 625 | 7776 | 117649 | 2097152 | 43046721 |
| Parameter value | 0 | - | 9 | 176 | 2900 | 50472 | 976227 | 21133632 |
| | 1 | - | 4 | 99 | 1712 | 29125 | 540576 | 11233250 |
| | 2 | - | 1 | 44 | 900 | 15680 | 283250 | 5665896 |
| | 3 | - | - | 11 | 380 | 7587 | 138544 | 2693425 |
| | 4 | - | - | - | 92 | 3000 | 61389 | 1195056 |
| | 5 | - | - | - | - | 697 | 22632 | 484020 |
| | 6 | - | - | - | - | - | 5036 | 166208 |
| | 7 | - | - | - | - | - | - | 35443 |
| | 1000000 | 9 | 50 | 295 | 1792 | 11088 | 69498 | 439791 |

Solution count for deepest_valley: domains $0..n$




**See also**

**common keyword:** `highest_peak`, `valley` *(sequence)*.

**implies:** `between_min_max`.

**Keywords**

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

**combinatorial object:** sequence.

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

**constraint network structure:** sliding cyclic(1) constraint network(2).

**filtering:** glue matrix.

**modelling:** functional dependency.

**Automaton** Figure 5.252 depicts the automaton associated with the `deepest_valley` constraint. To each pair of consecutive variables $(\mathtt{VAR}_i, \mathtt{VAR}_{i+1})$ of the collection `VARIABLES` corresponds a signature variable $S_i$. The following signature constraint links $\mathtt{VAR}_i$, $\mathtt{VAR}_{i+1}$ and $S_i$:

$\mathtt{VAR}_i < \mathtt{VAR}_{i+1} \Leftrightarrow S_i = 0 \wedge \mathtt{VAR}_i = \mathtt{VAR}_{i+1} \Leftrightarrow S_i = 1 \wedge \mathtt{VAR}_i > \mathtt{VAR}_{i+1} \Leftrightarrow S_i = 2$.

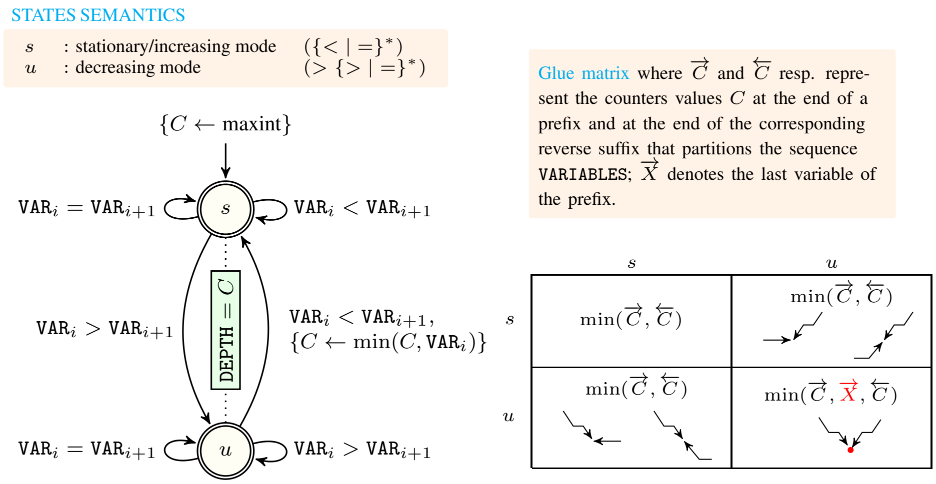



Figure 5.252: Automaton of the `deepest_valley` constraint and its glue matrix (state $s$ means that we are in *increasing* or *stationary* mode, state $u$ means that we are in *decreasing* mode, a new valley is detected each time we switch from decreasing to increasing mode and the counter $C$ is updated accordingly); maxint is the largest integer that can be represented on a machine

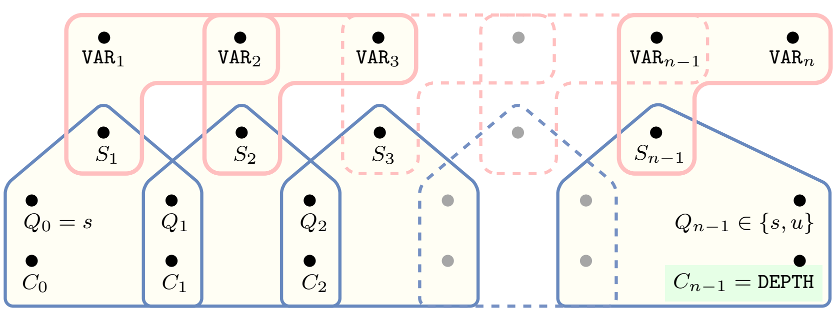



Figure 5.253: Hypergraph of the reformulation corresponding to the automaton of the `deepest_valley` constraint ($C_0$ is set to maxint the largest integer that can be represented on a machine)