Technical appendix

1 List of elementary operations

1.1 Transformation layer

- Identity

$$id(x_i) = x_i$$

- Number of elements on the right equals to x_i

$$Count^r_{=}(x_i) = |\{x_j : j > i \ \wedge \ x_j = x_i\}|$$

- Number of elements on the right smaller than x_i

$$Count^r_{<}(x_i) = |\{x_j : j > i \ \wedge \ x_j < x_i\}|$$

- Number of elements on the right greater than x_i

$$Count^r_{>}(x_i) = |\{x_j : j > i \ \wedge \ x_j > x_i\}|$$

- Number of elements on the left equals to x_i

$$Count^l_{=}(x_i) = |\{x_j : j < i \ \wedge \ x_j = x_i\}|$$

- Number of elements on the left smaller than x_i

$$Count^l_{<}(x_i) = |\{x_j : j < i \ \wedge \ x_j < x_i\}|$$

- Number of elements on the left greater than x_i

$$Count^l_{>}(x_i) = |\{x_j : j < i \ \wedge \ x_j > x_i\}|$$

- Number of elements equals to x_i + param

$$Count_{=+p}(x_i) = |\{x_j : x_j = x_i + param\}|$$

- Number of elements smaller than x_i + param

$$Count_{<+p}(x_i) = |\{x_j : x_j < x_i + param\}|$$

- Number of elements greater than x_i + param

$$Count_{>+p}(x_i) = |\{x_j : x_j > x_i + param\}|$$

- Max(0, x_i - param)
- Max(0, param - x_i)
- Max(0, $x_i - x_{i+1}$)
- Max(0, $x_{i+1} - x_i$)
- Number of elements equals to x_i

$$Count_{=}(x_i) = |\{x_j : x_j = x_i\}|$$

- Number of elements smaller than x_i

$$Count_{<}(x_i) = |\{x_j : x_j < x_i\}|$$

- Number of elements greater than x_i

$$Count_{>}(x_i) = |\{x_j : x_j > x_i\}|$$

- Number of elements greater than or equals to x_i AND less than or equals to x_i + param

$$Count_{>=<+p}(x_i) = |\{x_j : x_j \geq x_i \wedge x_j \leq x_i + param\}|$$

1.2 Comparison layer

- $id(x) = x$
- $|x - param|$
- $Max(0, param - x)$
- $Max(0, x - param)$
- $Euclidian_p(x)$: If(x == param) then 0 else 1 + $\frac{|x-param|}{maximal\ domain\ size}$
- $Euclidian(x)$: If(x == 0) then 0 else 1 + $\frac{x}{maximal\ domain\ size}$
- |x - number of variables|
- Max(0, number of variables - x)
- Max(0, x - number of variables)

2 Most frequently learned error functions

2.1 Over complete spaces

Constraints	Most frequent error function
all_different-4-5	$Count_{>0}\Big(Count^{l}_{=}(\vec{x})\Big)$
linear_sum-3-8-12	$Euclidian_{p}\Big(\sum_{i=1}^{n}(x_i)\Big)$
minimum-4-5-3	$Count_{>0}\Big(\ Max(0,\ p\ -\ x_i)\ with\ 1 \leq i \leq n\Big)$
no_overlap-3-8-2	$Euclidian\Big(\sum\Big(Count_{<+p}(\vec{x}) \times Count_{>=<+p}(\vec{x})\Big)\Big)$
ordered-4-5	$Count_{>0}\Big(Max(0,\ x_i\ -\ x_{i+1})\ with\ 1 \leq i \leq (n-1)\Big)$

Most frequent error function found for each constraint over small complete constraint spaces.

2.2 Over incomplete spaces

Constraints	Most frequent error function
all_different-12-12	$Count_{>0}\Big(Count_{=}(\vec{x}) \times Count_{>}(\vec{x})\Big)$
linear_sum-12-12-42	$Euclidian_{p}\Big(\sum_{i=1}^{n}(x_i)\Big)$
minimum-12-12-6	$Count_{>0}\Big(\ Max(0,\ p\ -\ x_i)\ with\ 1 \leq i \leq n\Big)$
no_overlap-8-32-3	$Count_{>0}\Big(Count_{=}(\vec{x}) \times Count_{>=<+p}(\vec{x})\Big)$
ordered-12-12	$Count_{>0}\Big(Count_{>}(\vec{x}) \times Count^{r}_{<}(\vec{x})\Big)$

Most frequent error function found for each constraint over large incomplete constraint spaces.