# Constraint Programming
# Lab 3.

20 January 2022

## 1 Global constraints `all-diff` and `GCC`

Achieve arc-consistency for this constraints :

1. `all-different`$(X_1, X_2, X_3, X_4, X_5, X_6)$,
   where $D_{X_1} = \{1, 3\}$, $D_{X_2} = \{4, 5\}$, $D_{X_3} = \{2, 3\}$, $D_{X_4} = \{4\}$, $D_{X_5} = \{4, 5, 6, 7\}$, $D_{X_6} = \{6, 7\}$.

2. `GCC`$(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, a, b, c, d, e, l = \{1, 1, 1, 0, 0\}, u = \{3, 2, 1, 2, 2\})$,
   où $D_{X_1} = \{a, b\}$, $D_{X_2} = \{a, b\}$, $D_{X_3} = \{a, b\}$, $D_{X_4} = \{a, b\}$, $D_{X_5} = \{a, b, c\}$, $D_{X_6} = \{b, c, d, e\}$, $D_{X_7} = \{c, e\}$ $D_{X_8} = \{a, b\}$, $D_{X_9} = \{c, e\}$ .

## 2 A snack in the kindergarden [Exam]

8 children have a snack. Each one has a right to take one fruit. There are 2 apples, 2 pears, 1 orange, 1 grapefruit, and 3 bananas. Favourite fruits of children are :

| | |
|---|---|
| François | apples |
| Arthur et Tomas | apples, pears |
| Maxime | pears |
| Emma | pears, bananas |
| Marie | oranges, grapefruits |
| Lisa et Mathilde | oranges, bananas |

If Emma takes a pear, can other children take their favourite fruits ? Answer this question using the propagation algorithm for a global constraint.

## 3 Global constraint `disjunctive`

We have the following CSP :
— 4 variables : $X_1, X_2, X_3, X_4$.
— Domains : $D_{X_1} = [0, 18]$, $D_{X_2} = [3, 9]$, $D_{X_3} = [1, 10]$, $D_{X_4} = [13, 24]$.
— One constraint : `disjunctive`$(X_1, X_2, X_3, X_4, p = \{4, 3, 4, 2\})$.
Could you reduce the domains of variables ?

## 4 Global constraint `element`

We consider the following CSP
— Variables : $X$, $Y$, $Z$.
— Domains : $D_X = \{5, 6, 7, 8\}$, $D_Y = \{1, 3, 5\}$, $D_Z = \{2, 4\}$.
— Constraint : $X = v_Y + w_Z$, where $v = [1, 5, 3, 4, 1]$ and $w = [4, 1, 4, 2, 5]$
Make this CSP arc-consistent.

## 5 Send More Money — continuation

Solve the following cryptogramme by using a dynamic variable instantiation heuristic (model with carried numbers)

$$\begin{array}{ccccc} & S & E & N & D \\ + & M & O & R & E \\ \hline M & O & N & E & Y \end{array}$$

## 6 Queens problem

1. Solve the 6-queens problem using the *Forward Checking* algorithm.
2. If we maintain arc-consistency (algorithm $MAC$), can we solve this problem faster ?