Constraint Programming
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Assignment #2

Exercise 1 (CLP Cryptoarithmetic Puzzle)**.**
Replace distinct letters by disctinct digits (numbers have no leading zeros), s.t. the following calculation holds.

		T	E	S	T	E
+		F	E	S	T	E
+		D	E	I	N	E
=	K	R	Å	F	T	E

a) Stick to the example presented in the course and use the library `clpfd`.
b) Write a predicate `distinct(L)` which is true if all elements from list `L` have a value from $\{0, 1, \ldots, 9\}$ and are (pairwise) distinct. Use the library `clpq`.

CCLP

We use (a subset of) the Constraint Handling Rules (CHRs) to program in the CCLP paradima. The following CCLP-clause

$$H \leftarrow C : D \mid G$$

is written by

```
N @ H <=> C , D | G
```

where `N @` is an optional name for the rule.

(1) Read the SICStus manual on how to use CHRs. Before using CHR rules, the CHR library and a handler must be set by `:- use_module(library(chr)). handler h.`
(2) In order to differentiate (built-in) predicates from constraints, the latter have to be declared, e.g. `constraints con/1.`
(3) The rule `N @ H <=> C | G` is a short form of `N @ H <=> C , true | G`.

Exercise 2 (Comparison of CLP and CCLP)**.**
Compare the following CLP- (in the left column) and CCLP-programs (in the right column), which consist of *one* of the given rules by posing the queries given below. Check your answers with the system's answers. Make sure, you understand why seemingly innocous rules produce different answers.

```
p(a) :- true.
p(X) :- X=a.
p(X) :- X = a, X = b.
```

```
p1 @ p(a) <=> true | true.
p2 @ p(X) <=> X=a | true.
p3 @ p(X) <=> true | X=a.
p4 @ p(X) <=> true , X = a | true.
p5 @ p(X) <=> X = a , X = b | true.
```

Queries: (a) `p(a)`, (b) `p(b)`, and (c) `p(C)`.

Exercise 3. Implement the following three variants of the CCLP program `min` (minimum) in CHR:

- Variant 1:

$$min1_1(X, Y, Z) \leftarrow \top \mid X \leq Y, Z \doteq X$$
$$min1_2(X, Y, Z) \leftarrow \top \mid Y \leq X, Z \doteq X$$

- Variant 2:

$$min2_1(X, Y, Z) \leftarrow X \leq Y \mid Z \doteq X$$
$$min2_2(X, Y, Z) \leftarrow Y \leq X \mid Z \doteq X$$

- Variant 3:

$$min3_1(X, Y, Z) \leftarrow X \leq Y : Z \doteq X \mid \top$$
$$min3_2(X, Y, Z) \leftarrow Y \leq X : Z \doteq X \mid \top$$

Test and explain the different reponses of the variants by posing the following six queries (only one at a time).

```
min(1,2,C).   min(A,2,1).   min(A,2,3).
min(A,A,B).   min(1,2,1).   min(1,2,3).
```