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assignment #7 (winter term 2005) solutions will be presented Tuesday, 13-Dec-2005, 2 PM, o27/2203 http://www.informatik.uni-ulm.de/pm/index.php?id=112

Exercise 1. The addition of natural numbers written in successor notation (the natural number 3 is written as s(s(s(0))) can be implemented by:

add(0,X,X).

add(s(X),Y,s(Z)) := add(X,Y,Z).

Write a constraint solver in CHR, that solves as many as possible single add-constraints, e.g., the first Prolog clause implies:

add(0,Y,Z) <=> Y=Z. add(X,Y,Y) <=> X=0.

Exercise 2. Use the CHR Constraint leq/2 from assignment #6-3 for a "constrain-and-generate" version of the sorting example from assignment #4-3. To this end, replace the clpq-Constraint =< by the CHR-constraint leq.

Your tests should (at least) include the following queries

- ?- permsortCHR([1,A,3],[1,3,7]).
- ?- permsortCHR([2,A],X).
- ?- permsortCHR([A,B,A],X).
- ?- permsortCHR(List,[1,X,3]).
- ?- permsortCHR([1,X,Y],[X,1,Y]), permsortCHR([4,5,10], [Z,Y,W]).

Exercise 3. Write a CHR program for the maximum(X,Y,Z)-constraint, which succeeds iff Z is the maximum of X and Y. Use your implementation of the leq/2- and less/2-constraints from assignment #5-3. Consider the following items in this order:

- a) Write a CHR rule, which computes the maximum Z of two given numbers X and Y.
- b) Enhance by inserting a CHR rule, such that queries like ?- maximum(X,X,3) can be handled satisfactorily (we expect X = 3).
- c) Insert a CHR rule which, given the constraint maximum(X,Y,Z), propagates the constraints X leq Z and Y leq Z.

Test your program with the query ?- maximum(A,B,C),maximum(C,A,B).

d) The query maximum(X,3,X) is solved (using (a-c)) to the conjunction of maximum(X,3,X) and 3 leq X.

Explain the connection between these two constraints.

- e) Insert CHR rules, such that under a given unequality between X and Y (e.g. X leq Y) the constraint maximum(X,Y,Z) is replaced by the implied equality (e.g. Y = Z).
- f) Explain, why the anwer to the query ?- maximum(X,3,X) (using (a-e)) is different from the one in d).
- g) Insert a CHR rule, such that for a query like ?- X less Z, maximum(X,Y,Z) the anser Y=Z is returned.
- h) In order to handle queries like ?- maximum(X,Y,3),maximum(X,Y,5) in a satisfactory manner, extend the program for a rule for this class of queries.
- i) Which are the sufficient conditions, given that two variables are unequal, to allow more inferences from maximum(X,Y,Z).

Implement this case by (additional) rules in your CHR program.

Exercise 4. Sudoku (Number Place) is a logic-based placement puzzle on a 9×9 board: "Fill in the grid so that every row, every column, and every 3x3 box contains the digits 1 through 9." [http://www.sudoku.com].

Write a clpfd-based Sudoku solver and run test cases for at least three instances of the puzzle. You can find (lots of) additional information on the web.