Exercise 3

Foundations of Logic Programming

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Exercise 3.1

Find a program P and a query Q such that for some θ there is a proof of $Q\theta$ (i.e. a successful SLD-derivation providing θ) via some selection rule R which cannot be found if Standardization Apart (Slide III/15) were not required.

Can you specify P and Q such that the problem occurs no matter which selection rule is applied?

Exercise 3.2

Consider the program

```
fact(0,s(0)).
fact(s(N),F):- fact(N,F1), mul(s(N),F1,F).
```

and the query `?- fact(0,Y),fact(Y,s(0)).`

a) Give an SLD-derivation using the Prolog selection rule (you don't have to show the multiplication in detail). Give the substitutions and resultants of each step and the CAS.

b) Show that the Switching Lemma (Slide III/26) holds for the initial query (i.e., for $n = 0$).

Hint: Give a second SLD-derivation selecting the second atom at the beginning and using the Prolog selection rule afterwards. Show the correspondence of both derivations.

Exercise 3.3

Give a program P, a query Q and two selection rules R_1 and R_2 such that:

- every SLD-derivation of $P \cup \{Q\}$ via R_1 is infinite
- every SLD-derivation of $P \cup \{Q\}$ via R_2 is failed

Is it possible to construct P and Q such that additionally to the properties specified above there exists a successful SLD-derivation via some selection rule R_3? Justify your answer.

Exercise 3.4

Consider the following definition of a selection rule R:

"Choose the atom A of the query such that the number of elements in $var(A)$ is minimal; in case several atoms have the same minimal number of variables, choose the rightmost."

Moreover, consider the following program P:

```
add(X,0,X).
add(X,s(Y),s(Z)) :- add(X,Y,Z).

mul(X,0,0).
mul(X,s(Y),Z) :- mul(X,Y,Z1), add(Z1,X,Z).
```

and a query $Q =$ `mul(X,Y,s(0)).` Solve the following tasks:

a) Build the SLD-tree for $P \cup \{Q\}$ via R.

b) Find a selection rule R' such that there is a successful derivation which always uses the first applicable program clause in P. Build the SLD-tree for $P \cup \{Q\}$ via R'.