

# Foundations of Logic Programming

## Tutorial 3 (on December 8th)

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WS 2014/15

### Exercise 3.1:

Consider the following program  $P$ :

```
double(0,0).  
double(s(X),s(s(Y))) :- double(X,Y).
```

- Give the Herbrand universe  $HU_F$  and the Herbrand base  $HB_{\Pi,F}$  determined by  $P$ .
- Give two models of  $P$ .
- Consider the following interpretations  $I_1$  and  $I_2$ . For each case specify whether the given interpretation satisfies  $P$  or not. Justify your answer.
  - $I_1 : D_{I_1} = \mathbb{N}, 0_{I_1} = 1, s(t)_{I_1} = 2 \times t_{I_1}, double_{I_1} = \{(a, a^2) \mid a \geq 1\}$
  - $I_2 : D_{I_2} = \mathbb{N}, 0_{I_2} = 0, s(t)_{I_2} = (2 \times t_{I_2}) + 1,$   
 $double_{I_2} = \{(0, 0)\} \cup \{(a, a^2 - a + 1 \mid a \geq 1)\}$

### Exercise 3.2:

Consider the following program which specifies the descendant relation which is the relation of being a child of, or a child of a child of, or a child of a child of a child of, ...

```
descend(X,Y) :- child(X,Y).  
descend(X,Y) :- child(X,Z), descend(Z,Y).
```

With the input database

```
child(anne, bridget).  
child(bridget, caroline).  
child(caroline, donna).  
child(donna, emily).
```

Give the search tree for the query:  $?- \text{descend}(\text{anne}, \text{donna})$ .

**Exercise 3.3:**

Consider the program from Exercise 3.2. What happens if we change the order of the rules and goals. What is the result of the queries `?- descend(X,Y).`, `?- descend(anne,emily).` and `?- descend(anne,bridget).`

- a) `descend(X,Y) :- child(X,Z), descend(Z,Y).`  
`descend(X,Y) :- child(X,Y).`
- b) `descend(X,Y) :- descend(Z,Y), child(X,Z).`  
`descend(X,Y) :- child(X,Y).`
- c) `descend(X,Y) :- child(X,Y).`  
`descend(X,Y) :- descend(Z,Y), child(X,Z).`

**Exercise 3.4:**

Consider the following program for addition.

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

Give the search tree and instantiations for the query:

```
?- add(s(s(s(0))), s(s(0)), R).
```