Exercises due on: Tuesday, May 19th, 10 AM (before class)

Semantic Theory 2015: Exercise sheet 2

Exercise 1

1.1 Derive the types of the underlined expressions in the following sentences. The subscripts indicate the types of the relevant expressions. All complete sentences must be of type t.

a. [Darth Vader]$_e$ is <u>the father of</u> Luke$_e$.

b. <u>Every</u> Jedi$_{\langle e,t\rangle}$ has [a lightsaber]$_e$.

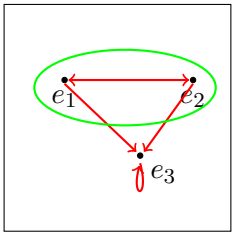
c. [Padmé Amidala]$_e$ is the <u>most</u> beautiful woman$_{\langle e,t\rangle}$ on Naboo$_e$.

1.2 Is it possible to have type theoretic expressions A and B such that both $A(B)$ and $B(A)$ are well-formed? Motivate your claim.

Exercise 2

The diagram graphically represents a model structure $M = \langle U, V\rangle$ with a universe consisting of three entities. The green circle indicates the set of Jedi, the arrow indicates the helping relation.

M:



2.1 Give the interpretation function V_M for the following non-logical constants:

a. anakin', yoda', padmé' $\in$ CON$_e$

b. jedi' $\in$ CON$_{\langle e,t\rangle}$

c. help' $\in$ CON$_{\langle e,\langle e,t\rangle\rangle}$

2.2 Compute the denotations of the following expressions relative to the model structure M and some arbitrary variable assignment g. Here, x is a variable of type e, and F is a variable of type $\langle e, t\rangle$.

a. $[\![\textit{help'(padmé')}]\!]^{M,g} = ?$

b. $[\![\forall x(\textit{help'}(x)(x) \rightarrow \neg \textit{jedi'}(x))]\!]^{M,g} = ?$

c. $[\![\forall F \exists x(F(x))]\!]^{M,g} = ?$

Exercise 3

3.1 Translate the following English words into lambda expressions:

a. $\text{blond}_{\langle\langle e,t\rangle,\langle e,t\rangle\rangle}$ (use blond* as the underlying first-order predicate; the translation should show the intersective character of the modifier explained in the lecture slides)

b. $\text{on}_{\langle e,\langle\langle e,t\rangle,\langle e,t\rangle\rangle\rangle}$ (As in the sentence: "Padmé lives <u>on</u> Naboo")

c. $\text{only}_{\langle e,\langle\langle e,t\rangle,t\rangle\rangle}$ (As in the sentence: "<u>Only</u> Luke defeated Darth Vader")

3.2 Translate the following sentences into expressions of Typed Lambda Calculus, assuming the syntactic structure indicated by the brackets. Use function application and lambda conversions to arrive at the simplest possible expressions.

a. Padmé lives [on Naboo].

b. [Only Luke] [is a [blond Jedi]].

c. Darth Vader [fights [and destroys]].

d. [Luke [and Darth Vader]] fight.

Use the translations for *blond*, *on*, and *only* from exercise 3.1. In addition, use the following lexical entries (NB. there are two different translations for *and*, depending on its function!):

- Padmé_e, Naboo_e, Luke_e, $\text{Darth Vader}_e \mapsto$ p', n', l', d'
- $\text{live}_{\langle e,t\rangle}$, $\text{Jedi}_{\langle e,t\rangle}$, $\text{fight}_{\langle e,t\rangle}$, $\text{destroy}_{\langle e,t\rangle} \mapsto$ live', jedi', fight', destroy'
- $\text{is-a}_{\langle\langle e,t\rangle,\langle e,t\rangle\rangle} \mapsto \lambda F.F$
- $\text{and}_{\langle\langle e,t\rangle,\langle\langle e,t\rangle,\langle e,t\rangle\rangle\rangle} \mapsto \lambda P.\lambda Q.\lambda x(P(x) \wedge Q(x))$
- $\text{and}_{\langle e,\langle e,\langle\langle e,t\rangle,t\rangle\rangle\rangle} \mapsto \lambda x.\lambda y.\lambda P(P(x) \wedge P(y))$