Semantic Theory
week 5 – Generalised Quantifiers

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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 the father of Luke$_e$.

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

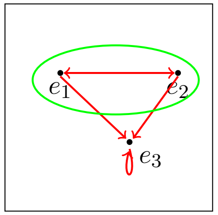
c. [Padmé Amidala]$_e$ is the most beautiful woman$_{\langle e,t\rangle}$ on Naboo$_e$.

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

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

Exercise 3

3.1 Translate the following English words into lambda expressions:

a. 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. on$_{\langle e,\langle\langle e,t\rangle,\langle e,t\rangle\rangle\rangle}$ (As in the sentence: "Padmé lives on Naboo")

c. only$_{\langle e,\langle\langle e,t\rangle,t\rangle\rangle}$ (As in the sentence: "Only 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$_e$, Darth Vader$_e$ $\mapsto$ p', n', l', d'
- live$_{\langle e,t\rangle}$, Jedi$_{\langle e,t\rangle}$, fight$_{\langle e,t\rangle}$, destroy$_{\langle e,t\rangle}$ $\mapsto$ live', jedi', fight', destroy'
- is-a$_{\langle\langle e,t\rangle,\langle e,t\rangle\rangle}$ $\mapsto \lambda F.F$
- and$_{\langle\langle e,t\rangle,\langle\langle e,t\rangle,\langle e,t\rangle\rangle\rangle}$ $\mapsto \lambda P.\lambda Q.\lambda x(P(x) \wedge Q(x))$
- and$_{\langle e,\langle e,\langle\langle e,t\rangle,t\rangle\rangle\rangle}$ $\mapsto \lambda x.\lambda y.\lambda P(P(x) \wedge P(y))$

From NPs to Determiners

Every man walked $\mapsto \forall x(\text{man}'(x) \rightarrow \text{walk}'(x))$

- *Every* $\Rightarrow \lambda P \lambda Q \forall x(P(x) \rightarrow Q(x))$

- $[\![\text{Every}]\!](A)(B) = 1$ iff $A \subseteq B$

▶ Syntactically, determiners are expressions that take a noun and a verb phrase to form a sentence.

▶ Semantically, the interpretation of a determiner can be seen as:

- a *function* from sets of entities to sets of properties: $\langle\langle e, t\rangle,\langle\langle e, t\rangle, t\rangle\rangle$

- a *relation* between two sets A and B, denoted by the NP and VP, respectively

Persistence

A determiner D is *persistent* in M iff: for all X, Y, Z:

- if D(X, Z) and X $\subseteq_M$ Y, then D(Y, Z)

Persistence test: If $[\![N_1]\!] \subseteq_M [\![N_2]\!]$, then DET N_1 VP $\vDash$ DET N_2 VP

- *Some men walked* $\vDash$ *Some human beings walked*
- *At least four girls were smoking* $\vDash$ *At least four women were smoking.*

Antipersistence

A determiner D is *antipersistent* in M iff: for all X,Y,Z:

- if D(X, Z) and Y ⊆ X, then D(Y, Z)

Antipersistence test: If ⟦N2⟧ ⊆ ⟦N1⟧, then DET N1 VP ⊨ DET N2 VP

- *All children walked* ⊨ *All toddlers walked*
- *No woman was smoking* ⊨ *No girl was smoking*
- *At most three Englishmen agreed* ⊨ *At most three Londoners agreed.*

Persistence and Monotonicity

Persistence (antipersistence)	$\Leftrightarrow$	upward (downward) monotonicity of the first argument.
		left-monotonicity (↑mon and ↓mon)
Upward (downward) monotonicity of noun phrases	$\Leftrightarrow$	upward (downward) monotonicity of the second argument of the determiner in the NP.
		right-monotonicity (mon↑ and mon↓)

Left and Right Monotonicity of Determiners

↑mon↑ *some*

↓mon↑ *all*

↓mon↓ *no*

↑mon↓ *not all*

Literature

- L.T.F. Gamut. Logic, Language, and Meaning. Vol 2. Chapter 7.
- Partee, ter Meulen, Wall. Mathematical Methods for Linguists. Chapter 14.
- Jon Barwise & Robin Cooper. Generalized Quantifiers. Linguistics and Philosophy. 1981.