Semantic Theory 2014 – Optional Exercise

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5.1 First-Order Logic, Interpretation

a. $S(j^*) \lor B(m^*)$
b. $\forall x(Sx \lor \neg Sx)$
c. $\forall x \forall y\, (Sx \land Bx \rightarrow Hxy)$
d. $\exists x Sx \longleftrightarrow \neg \forall y By$
e. $\exists x(\neg Sx \land \forall y\, (\neg m^* = y \rightarrow \neg Sy))$
f. $\forall x(Sx \rightarrow \exists x(Sx \land Hxy))$
g. $\forall x\, \forall y\, \forall z\, (Hxy \land Hxz \rightarrow Hxz)$

(i) Compute the truth conditions of the FOL formulas. Please, strictly follow the definitions from Lecture 2 (Interpretation for FOL). – It may help to take j*, m*, S, B, and H as translations of *John, Bill, student, blond,* and *help*, respectively, and to re-translate the formulas to English (not all of the translation make really sense, however).

(ii) Assume a model structure $M = \langle U, V \rangle$, with $U = \{b, j, m\}$, $V_M(j^*) = j$, $V_M(m^*) = m$, $V_M(S) = \{j, m\}$, $V_M(B) = \{b, m\}$, and $V_M(H) = \{ \langle j,m \rangle, \langle m,j \rangle, \langle j,b \rangle, \langle m,b \rangle, \langle b,b \rangle \}$. Basically, it is the model structure of Ex. 3.1, extended with a semantic value for the constant "B").

Determine, on the basis of the results of (i), the denotations, i.e., truth values, of the seven formulas in $M = \langle U, V \rangle$.

5.1 Type Theory, Interpretation

Please, just do Ex. 3.2 again, i.e.:

(i) Compute the truth conditions of (a) – (e), following the definitions of type theoretic interpretation.

(ii) Determine the denotations, i.e., the truth values, of formulas (a) – (c).

As noun-phrase coordinating conjunction, *and* can be translated to the following lambda expression (see Ex. 4.3 (d)):

$$\lambda P_{\langle et,\, t\rangle}\lambda Q_{\langle et,\, t\rangle}\lambda F_{et}[P(F) \wedge Q(F)]$$

Derive an FOL representation of the following sentence, using function application and β-reduction.

Every student and a professor work

Please, start from the type-logical translations of the lexical items, and do it (more or less) step by step.

5.2 Ditransitive verbs

Derive an FOL representation of the following sentence, using function application and β-reduction.

Mary [[gives Sally] a book]

Syntactic structure is indicated by brackets. Translate *Mary*, *Sally*, and *a book* to appropriate ⟨et, t⟩ expressions, assume for *give* the following translation:

$$\lambda P_{\langle et,\, t\rangle}\lambda Q_{\langle et,\, t\rangle}\lambda x[Q(\lambda y[P(\lambda z.\text{give*}(z)(y)(x))])] \qquad (\text{give*} \in \text{CON}_{\langle e,\, \langle e,\, \langle e,t\rangle\rangle\rangle})$$

Hint: Do not solve the exercise schematically, look carefully at the different application and reduction steps and try to understand their effect.

5.3 Negation

(a) *Bill doesn't work*

Assume that *doesn't* in sentences like (a) is a predicate modifier that converts a first-order predicate into its complement. Give a translation in terms of a lambda expression, and derive a representation for (a)

(b) *John, but not Bill works*

Treat *but not* as one basic expression, same type as *and* in Ex. 5.1. Give a translation and derive the sentence representation.

5.4 Prepositions

Do Ex. 4.2(c) again, but this time assume that the internal NP argument has the "correct" type ⟨et, t⟩. The type of the lambda expression therefore will be ⟨⟨et, t⟩,⟨et, et⟩⟩. Use $\text{in*} \in \text{CON}_{\langle e,\, \langle e,t\rangle\rangle}$ as the underlying FOL relation. Compute the representation of the following sentence:

Mary works in Saarbrücken

Hint: The problem is similar to the transitive-verb problem discussed in the lecture; accordingly, the translation will be structurally similar to (though not identical with) the translation of *read*.

5.5 Possessive construction

Assume that *Bill's car* has the syntactic structure *[[Bill s] car],* where the genitive marker "*s*" is treated as an independent word. Further assume that the possessive construction is an indefinite NP meaning something like "*a car that Bill has*", and take have*$\in CON_{\langle e, \langle e,t\rangle\rangle}$ to be the underlying FOL relation.

(a) Assume that the translation of the "*s*" is of type ⟨e,⟨et, ⟨et, t⟩⟩⟩, i.e., *Bill* translates to b* $\in CON_e$. Give the translation of "s" and compute the representation for the NP.

(b) Assume instead that the type of "*s*" is ⟨⟨et, t⟩,⟨et, ⟨et, t⟩⟩⟩, i.e., the immediate argument is a full NP denotation (think of *every student's car*), translate and compute the NP representation (for one of *Bill's car* and *every student's car*).