Semantic Theory 2015: Practice Exam (2014)

2. Type Theory

Consider the following sentence and its syntactic structure:

An unknown person robbed a bank.

$[_S[_{NP}[_{DET}\text{An}][_{N'}[_{ADJ}\text{unknown}][_N\text{person}]]]$
$\quad\quad[_{VP}[_V\text{robbed}][_{NP}[_{DET}\text{a}][_N\text{bank}]]]]$

(a) Give appropriate type-theoretic translations for the five words occurring in this sentence, and specify the type of each expression. The translation of "unknown" should use the constant `know*` of type $\langle e, \langle e, t\rangle\rangle$.

(b) Derive the semantic representation for the sentence, using basic composition rules and beta reduction. If you are not able to find a reasonable lambda term for "unknown", you may use `unknown` as translation for this part of the problem.

Solution

(a) The correct translations are given below:

- *An* $\mapsto \lambda P\lambda Q\exists x(P(x) \wedge Q(x)) :: \langle\langle e,t\rangle, \langle\langle e,t\rangle, t\rangle\rangle$
- *unknown* $\mapsto \lambda P\lambda x(P(x) \wedge \neg\exists y(\text{know*}(y, x))) :: \langle\langle e,t\rangle, \langle e,t\rangle\rangle$
- *person* $\mapsto \lambda x(\text{person}(x)) :: \langle e,t\rangle$
- *robbed* $\mapsto \lambda R\lambda x(R(\lambda y(\text{robbed}(x, y)))) :: \langle\langle\langle e,t\rangle, t\rangle, \langle e,t\rangle\rangle$ (type-lifted!)
- *a* $\mapsto \lambda P\lambda Q\exists x(P(x) \wedge Q(x)\rangle :: \langle\langle e,t\rangle, \langle\langle e,t\rangle, t\rangle\rangle$
- *bank* $\mapsto \lambda x(\text{bank}(x)) :: \langle e,t\rangle$

(b) The first part of the derivation (constructing the NP) looks as follows:

$$\begin{array}{ccc}
\text{An} & \text{unknown} & \text{person} \\
\lambda P\lambda Q\exists x(P(x) \wedge Q(x)) & \lambda P\lambda x'(P(x') \wedge \neg\exists y(\text{know*}(y, x'))) & \lambda x''(\text{person}(x''))
\end{array}$$

$$\lambda x'(\lambda x''(\text{person}(x''))(x') \wedge \neg\exists y(\text{know*}(y, x')))$$

$$\lambda x'(\text{person}(x') \wedge \neg\exists y(\text{know*}(y, x')))$$

$$\lambda Q\exists x(\lambda x'(\text{person}(x') \wedge \neg\exists y(\text{know*}(y, x')))(x) \wedge Q(x))$$

$$\lambda Q\exists x((\text{person}(x) \wedge \neg\exists y(\text{know*}(y, x))) \wedge Q(x))$$

The second part of the derivation (constructing the VP) looks as follows:

$$
\begin{array}{ccc}
\text{robbed} & \text{a} & \text{bank} \\
\lambda R \lambda x'(R(\lambda y(\text{robbed}(x', y)))) & \lambda P \lambda Q \exists x''(P(x'') \wedge Q(x'')) & \lambda x'''(\text{bank}(x'''))
\end{array}
$$

$$\lambda Q \exists x''(\lambda x'''(\text{bank}(x'''))(x'') \wedge Q(x''))$$

$$\lambda Q \exists x''(\text{bank}(x'') \wedge Q(x''))$$

$$\lambda x'(\lambda Q \exists x''(\text{bank}(x'') \wedge Q(x''))(\lambda y(\text{robbed}(x', y))))$$

$$\lambda x'(\exists x''(\text{bank}(x'') \wedge (\lambda y(\text{robbed}(x', y)))(x'')))$$

$$\lambda x'(\exists x''(\text{bank}(x'') \wedge \text{robbed}(x', x'')))$$

Finally, we combine the NP and the VP:

$$
\begin{array}{cc}
\text{[An unknown person]} & \text{[robbed a bank]} \\
\lambda Q \exists x((\text{person}(x) \wedge \neg \exists y(\text{know*}(y, x))) \wedge Q(x)) & \lambda x'(\exists x''(\text{bank}(x'') \wedge \text{robbed}(x', x'')))
\end{array}
$$

$$\exists x((\text{person}(x) \wedge \neg \exists y(\text{know*}(y, x))) \wedge \lambda x'(\exists x''(\text{bank}(x'') \wedge \text{robbed}(x', x'')))(x))$$

$$\exists x((\text{person}(x) \wedge \neg \exists y(\text{know*}(y, x))) \wedge \exists x''(\text{bank}(x'') \wedge \text{robbed}(x, x'')))$$