Computational Linguistics: Semantics

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1 Exercise 1a: From Relational to Functional Perspective

Look at the Knowledge Base used while doing the Exercises with Prolog and repeated below.

1. Harry is a wizard.
2. Hagrid scares Dudley.
3. All wizards are magical.
4. Uncle Vernon hates anyone who is magical.
5. Aunt Petunia hates anyone who is magical and scares Dudley.

Build a model for it by (i) writing your interpretation for $wizards, magical, scares, hates$ using the relational interpretation first, and then the functional one.

Solution:

$$\begin{array}{lcll}
[\![wizard]\!] & = & \{harry\} & \{x|wizard(x) = 1\} \\
[\![magical]\!] & = & \{harry\} & \{x|magical(x) = 1\} \\
[\![scares]\!] & = & \{(hagrid, dudley)\} & \{(x, y)|(scares\ (y))\ (x)\} \\
[\![hates]\!] & = & \{(vernon, harry)\} & \{(x, y)|(hates\ (y))\ (x)\}
\end{array}$$

(ii) Specifying the types of the expressions in your universe, and (iii) the domains of interpretation. E.g.

The domain of entities is as below:

$D_e = \{harry, hagrid, vernon, petunia\}$

Solution: $D_{(e\rightarrow t)} = \{magical, wizard\}$, $D_{(e\rightarrow(e\rightarrow t))} = \{scare, hates\}$

2 Exercise 2: Well formed formula

Let j be a constant of type e; M of type $e \rightarrow t$; S of type $((e \rightarrow t) \rightarrow (e \rightarrow t))$, and P of type $(e \rightarrow t) \rightarrow t$. Furthermore, x is a variable of type e, and Y a variable of type $(e \rightarrow t)$.

Determine which of the following is well-formed, give its type.

1. $(\lambda x.M(x))(P)$. [NWF]
2. $(\lambda x.M(x))(j)$. [WF]
3. $\lambda x.M(j)$. [NWF: vacus abstraction]
4. $S(\lambda x.M(x))$. [WF]
5. $(\lambda Y.Y(j))(M)$ [WF]
6. $\lambda x.(M(x) \wedge M(j))$ [WF]
7. $(\lambda x.M(x)) \wedge M(j))$ [NWF: $\lambda x.M(x)$ and $M(j)$ are of types $e \to t$ and t, resp. $\wedge$ coordinates terms of types t]

3 Exercise 3: β-conversion

Let j be a constant of type e; M of type $(e \to t)$, and A of type $e \to (e \to t)$. Furthermore, x and y are variables of type e, and Y is a variable of type $e \to t$. Reduce the following expression as much as possible by means of β-conversion.

1. $\lambda x(M(x))(j)$ [$M(j)$]
2. $\lambda Y(Y(j))(M)$ [$M(j)$]
3. $\lambda x \lambda Y(Y(x))(j)(M)$ [$M(j)$]
4. $\lambda x \forall y(A(x)(y))(j)$ [$\forall y.A(j)(y)$]
5. $\lambda x \forall y(A(x)(y))(y)$ [$\forall y.A(z)(y)$]
6. $\lambda Y(Y(j))\lambda x(M(x))$ [$M(j)$]
7. $\lambda Y \forall x(Y(x))\lambda y(A(x)(y))$ [$\forall z.A(x)(z)$]