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. Harry introduce Dudley to Hagrid.
4. All wizards are magical.
5. Uncle Vernon hates anyone who is magical.
6. Aunt Petunia hates anyone who is magical and scares Dudley.

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

(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:

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

Which other domains do you need?

2 Exercise 2: Well formed formula

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

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

1. $(\lambda x.M(x))(P)$.
2. $(\lambda x.M(x))(j)$.
3. $\lambda x.M(j)$.
4. $S(\lambda x.M(x))$.

5. $(\lambda Y.Y(j))(M)$
6. $\lambda x.(M(x) \wedge M(j))$
7. $(\lambda x.M(x)) \wedge M(j)$

3 Exercise 3: λ-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 expressions as much as possible by means of λ-conversion.

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

4 Exercise 4: λ-calculus and NL

Given,

- new $\lambda Y_{e\to t}.\lambda x_e.(Y(x) \wedge new(x))_t : (e \to t) \to (e \to t)$
- book $\lambda x_e.(book(x))_t : e \to t$
- john, $j : e$
- mary, $m : e$
- a present, $pr : e$.
- scares $\lambda x_e.\lambda y_e.(knows(x))(y)e \to (e \to t)$
- leaves, left $\lambda y_e.left(y) : e \to t$

build the meaning representation and the parse tree for the sentences below. Add the lexicon entries for "gives" and for "does not".

1. John left
2. John scares Mary
3. John does not leave
4. John does not scare Mary
5. John gives mary a present

Use the following CFG to build the parse trees. Again add the lexicon entries for "gives" and "does not" and extend the grammatical rules, if necessary.

```
s ---> np vp
vp ---> iv
vp --> tv np
n ---> adj n
adj ---> new
n ---> student
iv ---> left
tv --> scares
np --> mary, john, a present
```

5 Exercise 5: Generalized Quantifiers (22.03.07)

Recall that the meaning of GQ is as below.

$[\![\texttt{no N}]\!] = \{X \subseteq E \mid [\![\texttt{N}]\!] \cap X = \emptyset\}.$
$[\![\texttt{some N}]\!] = \{X \subseteq E \mid [\![\texttt{N}]\!] \cap X \neq \emptyset\}.$
$[\![\texttt{every N}]\!] = \{X \subseteq E \mid [\![\texttt{N}]\!] \subseteq X\}.$

Think of why these interpretations correspond to functions of type

$$((e \to t) \to t).$$

6 Exercise 6: λ-calculus and NL

Given,

- new $\lambda Y_{e \to t}.\lambda x_e.(Y(x) \wedge new(x))_t : adj$
- student $\lambda x_e.student(x))_t : n$
- a $\lambda X_{(e \to t)} \lambda Y_{(e \to t)} (\exists x_e.X(x) \wedge Y(x)) : det$
- left $\lambda y_e.left(y) : iv$

build the meaning representation and the parse tree for

1. A new student left

Use the following CFG to build the parse trees.

```
s ---> np vp
vp ---> iv
np ---> det n
n ---> adj n
det --> a
adj ---> new
n ---> student
iv ---> left
```