Compositional Logical Semantics in Prolog

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Jonas Lindh and Jessica Villing

We have implemented Lambda calculus to make a simple grammar with rules for compositional semantic interpretation. The grammar is written in Prolog using the built-in grammar formalism DCG. We were given a basic grammar containing rules for the phrases s (sentence), np (nominal phrase), vp (verb phrase), pn (proper name) and tv (transitive verb).

The grammar has been expanded with three vp structures; intransitive verbs (iv), predicatives (pr) and prepositional complements (pc). We have also added nouns (n), determiners (det) and adjectives (adj).

The rules for the iv and pr structures are similar, saying that an intransitive verb and a predicative is a verb that takes no argument:

\[
\text{vp(IV)} \rightarrow \text{iv(IV)}.
\]
\[
\text{vp(PR)} \rightarrow \text{pr(PR)}.
\]

We added rules for the lexical items *arrives* and *is canceled*, saying that the word is an intransitive verb and a predicative, resp.:

\[
\text{iv}(\lambda(X, \text{arrives}(X))) \rightarrow \text{[arrives]}.
\]
\[
\text{pr}(\lambda(X, \text{canceled}(X))) \rightarrow \text{[is, canceled]}.
\]

The rule for pc is similar to the one for tv, saying that a prepositional complement is followed by an np:

\[
\text{vp(PC@NP)} \rightarrow \text{pc(PC), np(NP)}.
\]

The lexical item *leaves for*:

\[
\text{pc}(\lambda(P, \lambda(X, \text{leaves_for}(X,Y)))) \rightarrow \text{[leaves, for]}.
\]

Nouns are treated the same way as intransitive verbs and predicatives:

\[
\text{np}(N) \rightarrow \text{n(N)}.
\]
\[
\text{n}(\lambda(X, \text{city}(X))) \rightarrow \text{[city]}.
\]
\[
\text{n}(\lambda(X, \text{company}(X))) \rightarrow \text{[company]}.
\]
The rules for the determiners *every* and *some* corresponds to the lambda expressions $\lambda P.\lambda V.\forall X(P@X \rightarrow V@X)$ saying that for all phrases $X$, the determiner $(P)$ followed by $X$ implies the phrase $V$ followed by $X$, and $\lambda P.\lambda V.\exists X(P@X \land V@X)$ saying that there is a phrase $X$ such that $P$ (the determiner) is followed by $X$ and the phrase $V$ is followed by $X$, resp. The structure rule says that a det is a part of an np where the det is followed by an np:

$$np(Det@NP) \rightarrow det(Det), np(NP).$$

$$det(\lambda P, \lambda (V, \forall (X, implies(P@X, V@X)))) \rightarrow [\text{every}].$$

$$det(\lambda P, \lambda (V, \exists (X, and(P@X, V@X)))) \rightarrow [\text{some}].$$

Finally we added rules for adj (adjectives) saying that adj is a part of an np similar to the det-rules above, and the lexical items rules says that the phrase $P$ (the adjective phrase) is followed by $X$ (the noun phrase), and it gives $X$ the property of being *large* and *scandinavian*, resp.:

$$np(Adj@NP) \rightarrow adj(Adj), np(NP).$$

$$adj(\lambda P, \lambda (X, and(large(X), P@X)))) \rightarrow [\text{large}].$$

$$adj(\lambda P, \lambda (X, and(scandinavian(X), P@X)))) \rightarrow [\text{scandinavian}].$$