Ambiguity & Cooper Storage

Cooper storage was an improvement over Montague’s technique because it didn’t force us to add new syntax rules just to satisfy our basic semantic principles (compositional semantics). However, there are ambiguities not handled well by this technique.

Consider the following sentences:

"Jane pets every dog of a teacher."

"Jane pets every dog that is owned by a teacher."

In each case is there one teacher or many? The complications involve nested NP’s. Does Cooper storage work? Let’s try the first version:

(Note the meaning of “of” is $\lambda v.\lambda w. (v @ (\lambda z. of (w, z)))$

\[
\langle PET(Jane, z_1), (\lambda u.\forall y. (dog(y) \land of(y, z_1) \rightarrow u@y), 2), (\lambda w.\exists x. (teacher(x) \land w@x), 1) \rangle
\]

Can pull either item out of storage. Let’s try pulling the universal statement off first. We get

\[
\langle \forall y. (dog(y) \land of(y, z_1) \rightarrow PET(Jane, y)), (\lambda w.\exists x. (teacher(x) \land w@x), 1) \rangle
\]

Retrieving the second item from the storage, we get:

\[
\langle \exists x. (teacher(x) \land \forall y. (dog(y) \land of(y, x) \rightarrow PET(Jane, y))) \rangle
\]

But if we pull them off in the opposite order we get:

\[
\langle \forall y. (dog(y) \land of(y, z_1) \rightarrow \exists x. (teacher(x) \land PET(Jane, y))) \rangle
\]

This is not what was desired, as we have the free variable $z_1$ which resulted from the nesting. Somehow we need to rule this out. We can do this by modifying the storage rule as suggested by Keller:

**Definition 1 Storage** (Keller) *If the store $\langle \phi, \sigma \rangle$ is a semantic representation for an NP, then the store $\langle \lambda u.@z_i, (\langle \phi, \sigma \rangle, i) \rangle$, for some some unique index, $i$, is also a representation for that NP.*

Once we have built this representation, we can complete the semantics by taking things out of storage in any order desired.

**Definition 2 Retrieval** (Keller): *Let $\sigma$, $\sigma_1$ and $\sigma_2$ be (possibly empty) sequences of binding operators. If the (nested) store $\langle \phi, \sigma_1, (\langle \beta, \sigma \rangle, i), \sigma_2 \rangle$ is for an expression of category $S$, then the store $\langle \beta@\lambda z_i, \phi, \sigma_1, \sigma, \sigma_2 \rangle$ is also associated with this expression.*

This provides the interpretation with the existential on the outside. The only way to get an interpretation with the universal on the outside is to not put anything into storage when processing information.

Find meaning of “Jane pets every dog of a teacher.”
\begin{center}
\begin{align*}
\langle \lambda u.(u@z,2),
& (\langle \lambda u.\forall y.(\text{dog}(y) \land \text{of}(y,u,z_1) \rightarrow u@y) \\
& (\langle \lambda w.\exists x.((\text{teacher}(x) \land w@x),1)),2)\rangle
\rangle
\end{align*}
\end{center}

Every dog of a teacher,
\begin{center}
\begin{align*}
\langle \lambda w.\lambda u.\forall y.(w@y \rightarrow u@y)) & \quad (\lambda u.\text{dog}(u) \land \text{of}(u,z_1)), \\
& (\langle \lambda w.\exists x.((\text{teacher}(x) \land w@x),1))\rangle
\end{align*}
\end{center}

dog of a teacher,
\begin{center}
\begin{align*}
\langle \lambda x.\lambda u.(v@u \land \text{of}(u,z_1)) & \quad (\lambda w.\exists x.((\text{teacher}(x) \land w@x),1))\rangle
\end{align*}
\end{center}

Now when retrieve, must first pull off universal reading before nested existential is available. Thus get the reading where a single teacher and all of his/her dogs.

The other reading is obtained if you avoid storing the sub-NP, a teacher. Then universal reading applies.