Glue Semantics and locality

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In this poster I will explore the idea that Glue Semantics enriched with an independently-motivated S4 modality could provide quite a natural account of some locality conditions. I will particularly focus on positive binding constraints.

In LFG, the standard way of expressing constraints on possible anaphor-antecedent relationships is via statements about the c-structure/f-structure/s-structure correspondence. For example, the requirement for the English reflexive pronoun herself to find its antecedent within the same clause (in this analysis, the same minimal subj-containing f-structure) can be stated by means of the correspondences given in (1) (Dalrymple 2001: Ch. 11, Asudeh 2004: 47f.).

(1) herself

\[ \lambda x(x, x) : (\uparrow_{\sigma} \text{ANTECEDENT}) \rightarrow (\uparrow_{\sigma} \otimes (\uparrow_{\sigma} \text{ANTECEDENT})) \]

The final line in (1) gives the lexical semantics of the pronoun in Glue: on the left of the colon there is a an expression of the lambda calculus, and on the right (what resolves to) a formula of linear logic, which constrains the combinatory potential of the lambda calculus expression. In this 'new Glue' approach, the fragment of linear logic functions as a type logic in the style of (type-logical) categorial grammar (Dalrymple et al. 1999). Notwithstanding the fact that in categorial grammar the type logic has to account for phenomena that in LFG are better accounted for by other parts of the architecture, the use of a type logic nevertheless opens up the possibility to adopt categorial grammar analyses of certain phenomena. That is what I propose to do.

Specifically, I propose to implement the analysis of Morrill (1990) of the clause-boundedness of expressions like herself (and perhaps others) by means of an extra, independently-motivated, connective in the fragment of linear logic used. The connective □ under consideration has the sequent calculus rules and associated operations in the (intensional) lambda calculus shown in (2), and the Curry-Howard propositions-as-types correspondence given in (3).

(2)

\[ \Gamma, f : A \vdash g : B \]
\[ \Gamma, h : \Box A \vdash g[\tau h/f] : B \]
\[ \Box \Gamma \vdash f : A \]
\[ \Box \Gamma \vdash \Box f : \Box A \]

(3) For any lambda calculus expressions f and g and type \( \tau \), any linear logic formula A, and any meaning constructors \( f : A \) and \( g : \Box A \), if \( f \) is of type \( \tau \) then \( g \) is of type \( s \rightarrow \tau \).

In (2), \( \Box \Gamma \) means that all the premises have \( \Box \) as their main connective. These rules give \( \Box \) the behaviour of necessity in S4 modal logic. It also has the same right (promotion) and left (dereliction) rules that \( ! \) has in standard linear logic—without the structural rules that \( ! \) has, of course (Moortgat 2011: 136–138).

As can be seen from (2) and (3), the semantic effect of \( \Box \) is int/extensionalization, in the style of Montague (1973). The reason I call the connective independently-motivated is that these are semantically-motivated operations. For example, we can give assign to the verb thinks the meaning
constructor shown in (4).

\[(4) \quad \text{think} : \Box((\uparrow \text{SUBJ})_\sigma \otimes \Box(\uparrow \text{COMP})_\sigma) \rightarrow \uparrow_\sigma)\]

This gives \(\text{think}\) the type \(s \rightarrow ((e \times (s \rightarrow t)) \rightarrow t)\), which makes sense, because semantically \(\text{thinks}\) takes a proposition (type \(s \rightarrow t\)) as its argument, not a truth value. What it also means, in combination with the rules given in (2), is that the locality condition on \(\text{herself}\) falls out naturally (but the command requirement still needs to be stated separately). To see this, we can look at (5), which has the interpretation paraphrased in (5-a) but not that in (5-b).

(5) Jane thinks that Martha trusts herself.
   a. \(\Rightarrow\) Jane thinks that Martha trusts Martha
   b. \(\not\Rightarrow\) Jane thinks that Martha trusts Jane

Suppose we have the underspecified meaning constructors shown in (6). For (5-a) we would need to have \(X := 4\), and for (5-b) we would need to have \(X := 2\).

(6) Jane thinks that Martha trusts herself.
   \[
   \begin{array}{cccc}
   \hline
   \text{think} : & \Box((2^e \otimes \Box 3^t) \rightarrow 1^t) & \Box 4^e & \Box((4^e \otimes 5^e) \rightarrow 3^t) & \Box(2^e \rightarrow (5^e \otimes X^e)) \\
   \hline
   \end{array}
   \]

Crucially, if we have \(X := 4\) then a proof of \(1^t\) is derivable, but if we have \(X := 2\) then it isn’t. Formally, we have the validity shown in (7) and the invalidity shown in (8).

(7) \(\Box 2^e, \Box((2^e \otimes \Box 3^t) \rightarrow 1^t), \Box 4^e, \Box((4^e \otimes 5^e) \rightarrow 3^t), \Box(4^e \rightarrow (5^e \otimes 4^e)) \vdash 1^t\)

(8) \(\Box 2^e, \Box((2^e \otimes \Box 3^t) \rightarrow 1^t), \Box 4^e, \Box((4^e \otimes 5^e) \rightarrow 3^t), \Box(2^e \rightarrow (5^e \otimes 2^e)) \not\vdash 1^t\)

The reason for the contrast between (7) and (8) is that the (semantically-motivated) requirement for the complement of \text{think} to be intensionalized, in combination with the right rule for \(\Box\), turns the complement clause into a proof-theoretic ‘island’ that the reflexive pronoun can’t ‘escape from’.

In the poster I will present this material in more detail, and discuss how it can be applied to other locality effects, for example quantifier scope. In this context, I will discuss the applicability of at least one other semantically-motivated modal connective. For Montague (1973), \(^\wedge\) meant abstraction over indices, conceived of as world-time pairs. However, for the application given above, it is sufficient to conceive of it as abstraction over worlds. The introduction of separate int/extensionalization operators to handle time-sensitivity (and a corresponding modal connective in linear logic) can be used to account for locality conditions that seem to crucially refer to tense or finiteness, and I will explore these connections in the poster.

References