Semantic reconstruction, higher-order alternatives

April 8, 2015

1 Overview of today

- Last week, we saw a new way to bring alternatives into the compositional fold, by allowing alternative generators to *take scope*.
- The system had a number of nice properties:
  - It did not require lexically generalizing to the worst case; expressions which induce alternatives can lexically denote (functions into) sets, but *nothing else needs to*.
  - It was more categorematic (and therefore more compositional) than standard ways of dealing with alternatives.
  - Because the compositional apparatus was standard, standard approaches to Predicate Abstraction could be imported straightaway.
  - Finally, though alternatives do take scope, we nevertheless predict that alternatives are able to expand outside the boundaries of an island. I suggested that the way this happens has a lot in common with theories of LF pied-piping (e.g. Nishigauchi 1990).
- Though we saw examples of how the system could handle a variety of cases, we left two important pieces unaccounted for: the possible **selectivity** of exceptional scope out of islands, and the fact that LF pied-piping in general needs to be accompanied by some form of **reconstruction** (e.g. in order to handle cases like *every philosopher*$_i$ *is happy if he*$_i$*'s cited by a famous expert on indefinites*).
- Today, I'll suggest that these issues are related, and that they are accounted for within the framework we started developing in the last meeting.
- Specifically, I'll show that both pieces of data are naturally explained as cases of *semantic reconstruction*, following e.g. Cresti 1995; Sternefeld 1998, 2001.

2 Review and exceptional scope

- Let's remind ourselves of the analysis we started building at our last meeting. The fundamental idea in that semantics was the following: the way alternative generators interact with their semantic context is not via Hamblin functional application, but rather via *scope-taking*.

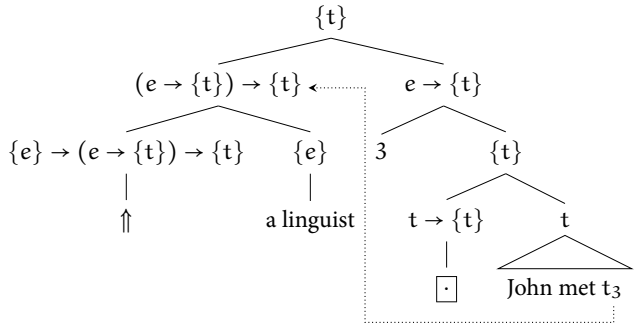

Figure 1: Using ⇑ and ⌜·⌝ to derive an alternative-set meaning for *John met a linguist*.

- As we saw, we could accomplish this with two type-shifters: ⌜·⌝ (i.e. IDENT, also known as Karttunen 1977's proto-question operator) and ⇑. The first of these shifts a meaning into a singleton set, and the second of these turns an alternative-denoting expression into something that takes scope...

$$\ulcorner x \urcorner = \{x\} \qquad m^{\Uparrow} = \lambda\kappa.\bigcup_{a \in m} \kappa\, a \tag{1}$$

- The second of these type-shifters is the really interesting one. It turns an alternative-denoting expression into a scope taker by finding a scope argument κ, feeding each a in the meaning of the alternative generator to κ, and finally collecting the results into one big set.
- A basic case with an alternative-generating indefinite works as in Figure 1. The lift shift ⇑ turns *a linguist*, which denotes the set of linguists, into a scope-taker that subequently QRs out of its base position; meanwhile, ⌜·⌝ adjusts the type of the remnant, turning it into a (trivial) set of propositions, the sort of thing over which *a linguist*$^{\Uparrow}$ can sensibly take scope.
- The meaning we derive for this case is the standard set of propositions of the form x left, with x ranging over the linguists:

$$\{\text{John met } x \mid \text{linguist } x\}$$

- Moreover, it is straightforward (as we saw) to extend this treatment to examples with multiple indefinites (to be qualified shortly), as well as single and

multiple *wh* questions. For example, a multiple *wh* question would receive the following analysis:

$$\text{who}^{\Uparrow}\,(\lambda x.\,\text{what}^{\Uparrow}\,(\lambda y.\,\boxed{x\ \text{read}\ y}\,)) \tag{2}$$

This is equivalent to the expected set $\{x\ \text{read}\ y \mid \text{person}\,x \wedge \text{thing}\,y\}$.

- Sidebar: I actually hadn't realized this when we met last week, but the semantics that Cresti 1995 gives to *wh* words is *identical to* the semantics of a lifted (that is, $\Uparrow$-shifted) *wh* word on our approach! Here, for example, is a Cresti-style meaning for *which linguist*:[1]

$$\lambda\mathbf{W}.\,\lambda p.\,\exists x.\,\text{ling}\,x \wedge \mathbf{W}\,x\,p \tag{3}$$

Ignoring intensions, the type of this expression is $(e \to t \to t) \to t \to t$. Abbreviating $\alpha \to t$ as $\{\alpha\}$, this is the same as $(e \to \{t\}) \to \{t\}$. This is, of course, precisely the type that we associate with *a linguist*$^{\Uparrow}$ in Figure 1. That expression has the following meaning:

$$\lambda\kappa.\,\bigcup_{x\,\in\,\text{ling}} \kappa\,x \tag{4}$$

In other words, both meanings take a function $\mathbf{W}$ from individuals into sets of propositions (we have been writing this function 'κ'), and return a new set of propositions, namely the one you get when you feed $\mathbf{W}$ (i.e. κ) each linguist x, and then collect all the results in one big set.

- End sidebar. This way to think about how alternatives are brought into the compositional fold has several important features:
  - Only the things which introduce alternatives need to have "unusual" denotations. Everything else keeps its Semantics 101 meaning.
  - It's categorematic.[2] Hamblinized theories of alternatives (i.e. ones making use of pointwise functional application) rely fairly systematically on syncategorematic meanings in cases where pointwise functional application is not desired. But we have no need for that — keeping the compositional machinery standard means that everything can be assigned a meaning, and everything can compose up via Functional Application (and Predicate Abstraction).
  - Similarly, because the compositional machinery is entirely standard, there is no need to devise a new semantics for Predicate Abstraction (which on the pointwise approach to composition needs to find a way to map a set of propositions into a set of functions). For this reason, the problems pointed out for the interplay of alternatives and binding by Shan 2004 and others do not arise.
  - Finally, despite the fact that alternative percolation relies on scope-taking, we still predict that alternatives can expand outside of islands — i.e. that alternatives can percolate past the scope-position of the original alternative generator. More generally, anything whose semantics is couched in terms of alternatives (e.g. indefinites, questions, disjunction, indeterminates, focus, etc.) is predicted to be the sort of thing that can take exceptional scope out of islands.
- We did not explore exceptional scope in much detail last week, so let's take a closer look now.
- As an example of how alternatives expand outside of islands, consider Reinhart 1997's famous *if a relative of mine dies, I'll inherit a house*. We analyze this as a case of LF pied-piping (e.g. Nishigauchi 1990) by first composing up the island *a relative of mine dies*, lifting the result into a scope-taker via $\Uparrow$, and giving the result scope over the conditional.

$$\{x\ \text{dies} \mid \text{relative}\,x\}^{\Uparrow}\,(\lambda p.\,\boxed{p \Rightarrow \text{house}}\,) \tag{5}$$

The result is equivalent to $\{x\ \text{dies} \Rightarrow \text{house} \mid \text{relative}\,x\}$. The effect is as if the alternative generator had *itself* taken scope over the conditional, even as it remains confined to its island.

- Still, a couple things remained unclear. For one, it was not obvious how to derive selectivity outside of islands, which the following sorts of examples seem to suggest we need:

(1) If ⟨a persuasive lawyer visits a relative of mine⟩, I'll inherit a fortune.

(2) Who knows ⟨who read what⟩? (and the Japanese analog)

(3) We only saw the entries MARILYN made about John.
We also only saw the entries ⟨MARILYN made about BOBBY⟩.

[1] Cresti 1995:96 fn.17 also gives a way to decompose a *wh* phrase into an indefinite and a question-y part. It seems possible that the second of these might be related to our $\Uparrow$ shifter, but I haven't had a chance to explore this issue yet.

[2] Modulo Predicate Abstraction, which is dispensible and/or categorematizable.

The apparent problem with these sorts of cases is that it would seem the thing to be pied-piped denotes a flat set of alternatives. In that event, there would be no way to give one source of alternatives scope out of the island without bringing the other along for the ride:

$$\begin{aligned}\{x \text{ visits } y \mid \text{lawyer } x \wedge \text{relative } y\}^{\Uparrow}(\lambda p.\boxed{p \Rightarrow \text{house}}) \\ = \{x \text{ visits } y \Rightarrow \text{house} \mid \text{lawyer } x \wedge \text{relative } y\}\end{aligned} \tag{6}$$

- Moreover, if LF pied-piping is really what's happening, how could the following sorts of examples — where an expression external to the island binds into the island to be LF-pied-piped — be explained? (Of course, this sort of issue would seem to characterize Nishigauchi 1990's account as well. At the moment, I am not sure this has been discussed in the literature.)

(4) Every linguist$_i$ is pleased if ⟨a famous expert on indefinites cites her$_i$⟩.

(5) Which boy$_i$ gets mad when ⟨he$_i$'s at a party with which girl⟩?

(6) Dono yonensei-mo$_i$ ⟨*pro*$_i$ dare-o sukida-to⟩ itta-ka?
wh 4th.grader-MO ⟨*pro*$_i$ who-Acc like-Comp⟩ said-KA
'Who did every fourth grader$_i$ say he$_i$ likes?'

The apparent problem with these cases, of course, is that (one might naturally think) there should be no way to move the island above the thing that binds into it, at least not without unbinding the pronoun in the process.

- In the following couple sections, I will try to give you a sense that, contrary to appearances, both sorts of data are accounted for. The first actually just falls out of the theory as already stated. The second requires a simple generalization of the framework to incorporate insights of e.g. Sternefeld 1998, 2001 *vis à vis* binding reconstruction.

3 Semantic reconstruction

- Empirical jumping-off point: the following sentence is intuitively ambiguous between two readings — on in which the quantified subject takes wide scope relative to negation, and another in which the quantified subject takes narrow scope relative to the negation.

(7) Every linguist wasn't at the party.

- Treating negation as a scope-taker is, most likely, not the way to go in accounting for this datum. For one, the behavior is much more general (e.g. *a unicorn seems to be approaching*). Moreover, in general negation does not interact scopally with other operators in the way that truly scopal expressions like quantified DPs do. E.g. the following sentence is not ambiguous (in particular, it doesn't admit an interpretation that entails any degree of uncertainty):

(8) John is certain not to be at the party.

- Instead, we might account for (7) with the following LF, on which the subject DP *every linguist* begins its life inside the vP and undergoes EPP movement (or something along those lines) to the canonical matrix subject position:

$$[\text{every linguist}]\ [1\ [_{vP}\ \text{not}\ [_{vP}\ t_1\ \text{at the party}]]] \tag{7}$$

- However, instead of assuming that the trace is interpreted as type e, instead we assume the trace has the type of a *quantifier*, namely type $(e \to t) \to t$. This means that the abstraction node takes the quantifier as an argument, rather than the more familiar reverse situation:

$$\begin{aligned}(\lambda \mathbf{Q}.\ \neg \mathbf{Q}\ \text{at.the.party})\ [\![\text{every linguist}]\!] \\ = \neg [\![\text{every linguist}]\!]\ \text{at.the.party}\end{aligned} \tag{8}$$

- This derives the "inverse" scope reading. In general, in a scopal configuration like $X\,(\lambda v.\,\phi)$, A will take scope over ϕ if A is has type $(\sigma \to \tau) \to \tau$, where σ is the type of the "trace" variable v, and τ is any "result" type (i.e. the type of ϕ). Conversely, X will take scope within ϕ if the type of the "trace" variable v is the same as the type of X. These two possible situations give rise to two patterns of function-argument application, schematized below:

$$\begin{aligned}X\,(\lambda v.\,\phi) \quad & [X \text{ takes scope } \textbf{over } \phi] \\ (\lambda v.\,\phi)\,X \quad & [X \text{ takes scope } \textbf{within } \phi]\end{aligned} \tag{9}$$

- Indeed, some folks (following Hornstein and others) have suggested that there may be no QR at all, and that inverse scope is generally derived by reconstructing the preceding quantifier into a position lower than the inversely scoping quantifier. Though Hornstein has a syntactic notion of reconstruction in mind, a semantic one would do just as well.

- Along these lines, Cresti argues that reconstruction is governed by *higher-order traces*. In conjunction with some ideas about how *wh* islands work, Cresti uses semantic reconstruction via higher-order traces to predict how far moved *wh* phrases can reconstruct.

- So what does all this have to do with us? The first thing to notice is that higher-order alternative sets are readily generated by our semantics. The only difference from the way the "flat" alternative set is derived is that in the higher-order case, we perform one more $\boxed{\cdot}$-shift than we did previously (here we analyze *a persuasive lawyer visits a relative of mine*):

$$\begin{aligned}&[\![\text{a relative}]\!]^{\Uparrow}\,(\lambda y.\,\boxed{[\![\text{a lawyer}]\!]^{\Uparrow}\,(\lambda x.\,\boxed{x \text{ visits } y}\,)}\,)\\ &\quad = \{\{x \text{ visits } y \mid \text{lawyer}\, x\} \mid \text{relative}\, y\}\end{aligned} \tag{10}$$

  Call the resulting higher-order meaning **S**. Incidentally, an analogous result can be achieved in Karttunen 1977-style approaches to the semantics of questions, by iterating the proto-question operator.

- Now, the key bit is that we can LF pied-pipe a higher-order alternative set in exactly the same way as the preceding simpler cases, which involved flat alternative sets. So for example, the following is a possible candidate meaning ($\exists$, recall, is the categorematic closure operation, namely $\lambda s.\,\exists p \in s.\,p$).

$$\mathbf{S}^{\Uparrow}\,(\lambda s.\,\boxed{\exists\, s \Rightarrow \text{house}}\,) \tag{11}$$

  This is equivalent to $\{\exists x.\,\text{lawyer}\, x \wedge x \text{ visits } y \Rightarrow \text{house} \mid \text{relative}\, y\}$. The "outer" layer of alternatives scopes above the conditional, while the "inner" layer of alternatives is grabbed by λs, and therefore reconstructs to within the scope of the conditional, where its alternatives are discharged by $\exists$.

- In this case, we gave the object-induced alternatives "scope" over the alternatives introduced by the subject. The reverse is, of course, possible as well. Moreover, it is obvious that we can, in principle, derive arbitrarily higher-order meanings in cases with more than just two indefinites, simply by freely iterating the application of $\boxed{\cdot}$. It follows that alternative generators are capable of taking fully selective scope outside of islands — we never need to collapse layers of alternatives if we do not wish to.

- By the way, higher-order alternative sets receive independent motivation. E.g., Dayal 1996, 2002 suggests that they can be used to account both for certain kinds of echo-questions, as well as the *wh* triangle effect (see also Fox

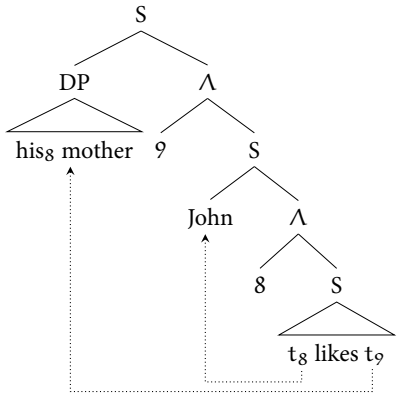

Figure 2: A structure for *his mother, John likes.*

2012 and Charlow 2014 §4.5.2 for some more arguments). I have not thought much about whether arbitrarily higher-order alternative sets could ever be useful in the semantics of questions (*wh* polygons??), but it's possible.

4 Binding reconstruction

- So that takes care of our first datum. Selective exceptional scope-taking is predicted by the general framework, and the explanation is couched in terms of semantic reconstruction. How about the second? How do we guarantee that indefinites on an island can take scope outside the island without thereby forcing *pronouns* on the island to be evaluated high, as well?

- Well, in a sense you might already be thinking that if semantic reconstruction could allow two indefinites on an island to be differentiated, it would stand to reason that there should be nothing forcing an island-bound pronoun to be evaluated high in case its island-mate indefinite is.

- I think this is a good intuition. But unfortunately, things are not quite so simple given the way we standardly think about assignment functions. The way that binding works in Heim & Kratzer 1998 is that pronouns are evaluated at their scope position, *period*. There is no possibility of binding reconstruction in such a system. For example, regardless of the type of the trace in Figure 2, the topicalized phrase will be evaluated at the "matrix" assignment function g.

- However, a minimal shift in perspective, following Sternefeld 1998, 2001, lets us treat binding reconstruction parallel to alternative-set reconstruction.
- To give a very brief précis (see Charlow 2014 for more detail), we will allow expressions to denote *functions over assignment functions*. This allows the tree in Figure 2 to be interpreted as in (12). A couple instances of β-reduction should be enough to convince you that g_8 ends up evaluating to j![3]

$$(\lambda F.\, \lambda g.\, \text{likes}\,(j,\, F\, g^{[8\to j]}))(\lambda g.\, \text{mom}\, g_8) \tag{12}$$

  To re-emphasize, in an approach like that of Heim & Kratzer 1998, nothing of the sort would be possible. The meaning of the highest S relative to an assignment function g would just be $[\![\Lambda]\!]^g\,[\![\text{DP}]\!]^g$. The topicalized DP is obligatorily interpreted at the "matrix" assignment function, rather than the "shifted" or "modal" assignment $g^{[8\to j]}$.
- This approach to binding reconstruction immediately scales up to quantifiers, as seen in (13) below. Again, this sort of thing would not be possible in a system like Heim & Kratzer 1998: the meaning of the highest S relative to an assignment function g would just be $[\![\text{DP}]\!]^g\,[\![\Lambda]\!]^g$. Though the function-argument relationship is reversed from the previous case, we still have it that the topicalized DP is obligatorily interpreted at the "matrix" assignment.

$$(\lambda F.\, \lambda g.\, \forall x \in \text{ling}.\, \text{likes}\,(x,\, F\, g^{[8\to x]}))(\lambda g.\, \text{mom}\, g_8) \tag{13}$$

- There is, incidentally, a good deal of independent motivation for this sort of perspective about the role of assignment functions in the grammar. Some key references are Sternefeld 1998, 2001; Kobele 2010; Kennedy 2014. This approach to the role of assignment functions in grammar is also characteristic of dynamic-semantic approaches (e.g. Muskens 1996; Brasoveanu 2007).
- Another nice thing about reckoning with assignments in this way is that it allows you to give a totally categorematic treatment of Predicate Abstraction! Here's a candidate meaning for an abstraction index on this approach:

$$[\![n]\!] = \lambda f.\, \lambda x.\, \lambda g.\, f\, g^{[n\to x]} \tag{14}$$

  The abstraction index n is type $(a \to \sigma) \to \epsilon \to a \to \sigma$, for any σ, ϵ, and where a is the type of assignment functions.

[3] The basic strategy here makes use of something known in the computer-science literature as a *thunk*. See also Barker 2012 on reconstruction as *delayed evaluation*.

- Let's get a sense for how this helps with binding reconstruction in a case like *every linguist*$_i$ *is pleased if* ⟨*a famous expert on indefinites cites her*$_i$⟩. First, we derive a higher-order meaning for the clause to be pied-piped:

$$\lambda g.\, \{\lambda h.\, \{x \text{ cites } h_0\} \mid x \in \text{indefs.expert}\} \tag{15}$$

- Though I'll gloss over the compositional details today, I'll note that this approach necessitates slightly different formulations of $\boxed{\cdot}$ and $\Uparrow$, as follows:

$$\boxed{x} = \lambda g.\, \{x\} \qquad m^{\Uparrow} = \lambda \kappa.\, \lambda g.\, \bigcup_{a \in m g} \kappa\, a \tag{16}$$

  These are just assignment-friendly versions of the earlier rules. Notice that **they are still decompositions of LIFT**. That is, $\Uparrow \circ \boxed{\cdot} = \lambda x.\, \lambda \kappa.\, \kappa\, x$ = LIFT!!
- Ok! So, call the meaning in (15) $\mathbf{m}$. Now, the relevant reading of our example with binding reconstruction can be given (schematically) as follows:

$$\mathbf{m}^{\Uparrow}\,(\lambda m.\, \cdots [\![\text{every ling}]\!]\,(\lambda y.\, \lambda h.\, \cdots m\, h^{[0\to y]} \cdots))) \tag{17}$$

  The implementational details are less important here than the basic fact that the LF-pied-piped things's "trace meaning" is $\lambda h.\, \{x \text{ cites } h_0\}$ — something looking for an assignment function h to fix the value of its "object" h_0. For this reason, semantically reconstructing it can place it in a position where it combines with a "modal" assignment — i.e. in (17), one that maps 0 to y.
- The overall effect, then is that the "indefiniteness" that characterizes the LF-pied-piped expression scopes high, but that nothing else on the island — be it another indefinite or a pronominal expression — is forced to.
- Overall, this approach seems to cut the pie in precisely the right way. Though an indefinite taking wide scope out of an island shoud not, it seems, force anything else on the island to take wide semantic scope, the wide scope of the indefinite itself behaves *in every respect* like true wide scope. For example, an indefinite cannot acquire scope over an operator that binds into its restrictor (cf. Schwarz 2001):

  (9) No candidate$_i$ submitted a paper he$_i$ wrote.

  This is as predicted. Any attempt to give *a paper he*$_n$ *wrote* scope over the subject will necessarily unbind the pronoun in the relative clause, since $\Uparrow$ gives indefiniteness wide scope, and here the indefiniteness is assignment-dependent: i.e. $[\![\text{a paper he}_n \text{ wrote}]\!] = \lambda g.\, \{x \mid \text{paper}\, x \wedge g_n \text{wrote}\, x\}$.

5 Concluding

- One way to think of where this leaves us: we have resurrected the LF pied-piping approach to island obviation, in a way that meets von Stechow 1996's objections to Nishigauchi 1990, but without the stipulations characteristic of von Stechow's treatment (namely, an extra level of post-LF representation, where certain things in the LF pied-piped phrase reconstruct).[4]
- There are some things we have not addressed:
  - Like, for instance, why only in situ *wh* seem to be able to take scope outside of islands (see Shan 2002 for an interesting approach related to the theory we've been developing).
  - Or focus! Or intervention effects, in Japanese and elsewhere.
  - Or, finally, what any of this has to do with dynamic semantics. (This turns out to be importantly related to the account of binding reconstruction we sketched, but the details will have to wait.)
- Next week: D. Bumford will talk to us about Bumford to appear, with a focus on dynamic semantics and its links to the perspective developed today.

[4] By the by, the theory also gives a nice account of garden-variety (i.e. overt) pied-piping.

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