Alternatives and binding

Computational semantics seminar

February 1, 2017

Review

Reminder: what we're up to

We're taking up fundamental questions about the orientation and organization of the grammar.

How to theorize about various enrichments?

- Alternatives
- Binding
- Presupposition
- Supplementation
- Dynamics of meaning

We're going to see how far we can push a *computational* perspective.

We're also interested in islands

One way or another, an 'enrichment' is able to percolate out of islands:

1. If [a rich relative of mine dies], I'll inherit a house. $^{\checkmark}\exists \gg$ **if**

We'd like to see if thinking in terms of *enrichments* can help us get a grip on this behavior. And we'd like to see if there's any empirical mileage to be gained by taking this perspective.

Island-insubordination, more generally:

1. ***Wh* in situ:**
   Which linguist will be offended if [we invite *which philosopher*]?

2. **Indeterminate pronouns:**
   [[*Dono hon-o* yonda] kodomo]-mo yoku nemutta.
   which book-acc read child mo well slept
   'For every book *x*, the child who read *x* slept well.'

3. **Association with focus:**
   John only gripes when [*MARY* leaves the lights on].

4. **Supplemental content:**
   John gripes when [Mary, *a talented linguist*, leaves the lights on].

5. **Presupposition projection:**
   John gripes when [*the King of France* leaves the lights on].

And even binding?

Might we think of binding-at-a-distance as a kind of exceptional scope?

1. Everybody$_i$ gets offended when [their$_i$ buddy leaves the light on].

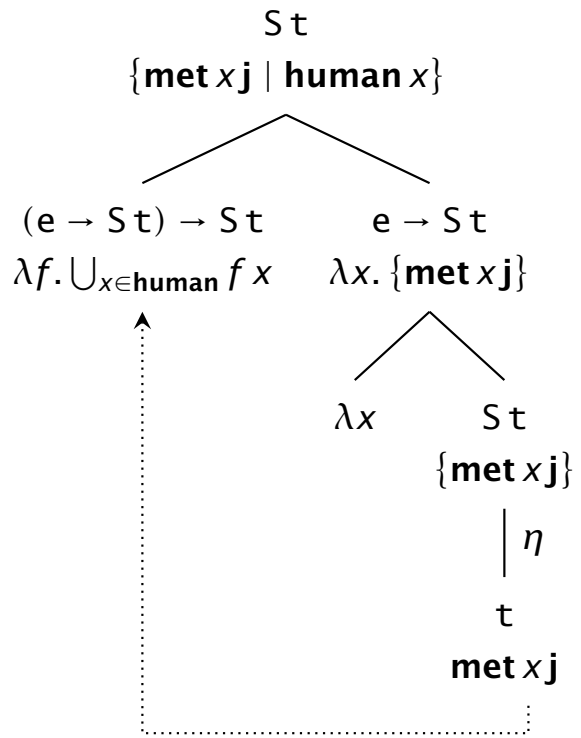
To be sure, this would be **highly** nonstandard.[1] But it's very much worth reflecting on *why* we think there are no exceptional scope issues here to begin with. How would you phrase the company line on this?

[1] Though, IDK. Some syntactians tell me things. . . .

Karttunen-esque

Questions via scope

Karttunen's (1977) approach to questions (or indefinites):



Where η, of course, is a mapping into a singleton set.

Breaking it down

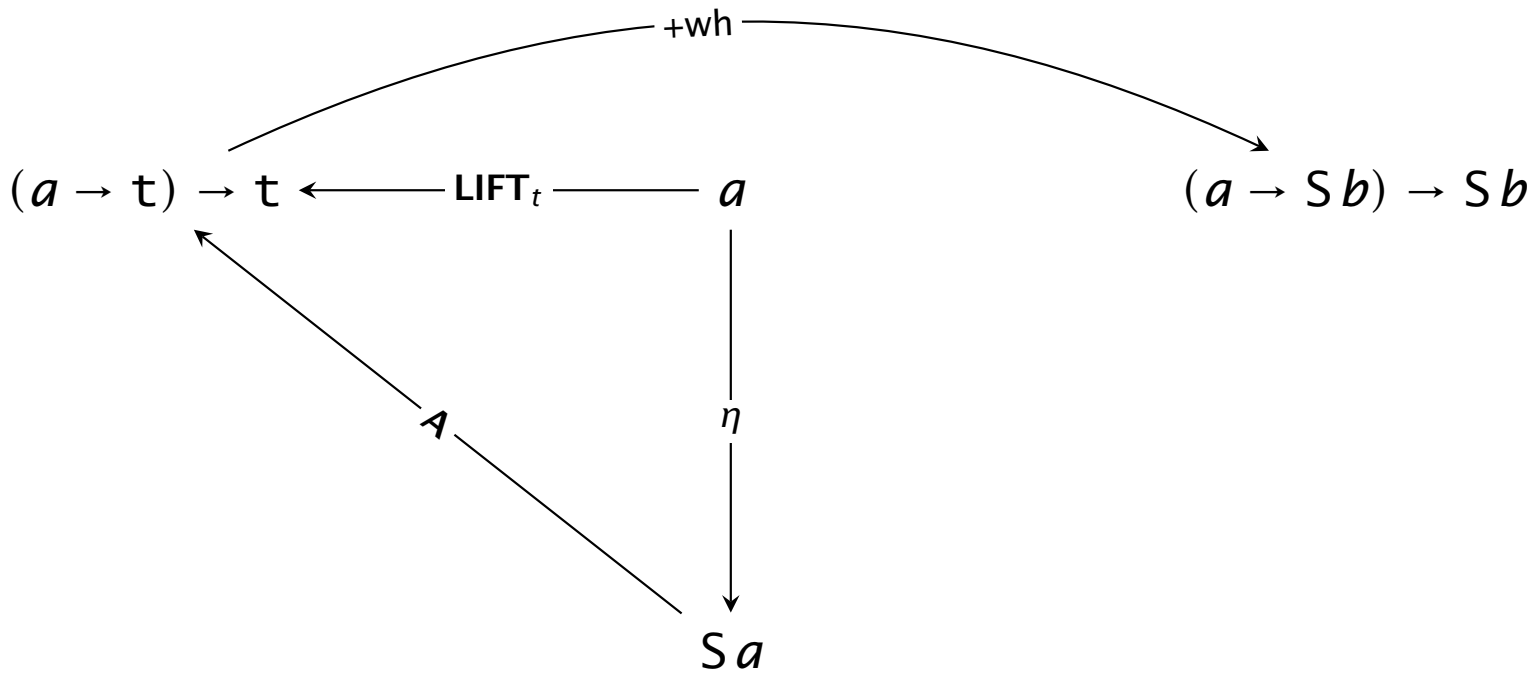
Recall that there's a question of how the alternative-y meaning for wh/indefinites might be derived. Should it be taken as basic?

Karttunen (1977), Cresti (1995) supposed not. They thought we should find a function to map GQs into things that scope over and return set of alternatives:

$$+wh :: ((\mathtt{e} \to \mathtt{t}) \to \mathtt{t}) \to (\mathtt{e} \to \mathtt{St}) \to \mathtt{St}$$
$$+wh := \lambda Q.\lambda f.\{y \mid Q(\lambda x.y \in f\,x)\}$$

So that's really $+wh[\![\text{someone}]\!]$

The Partee (1986) triangle+



Going another route

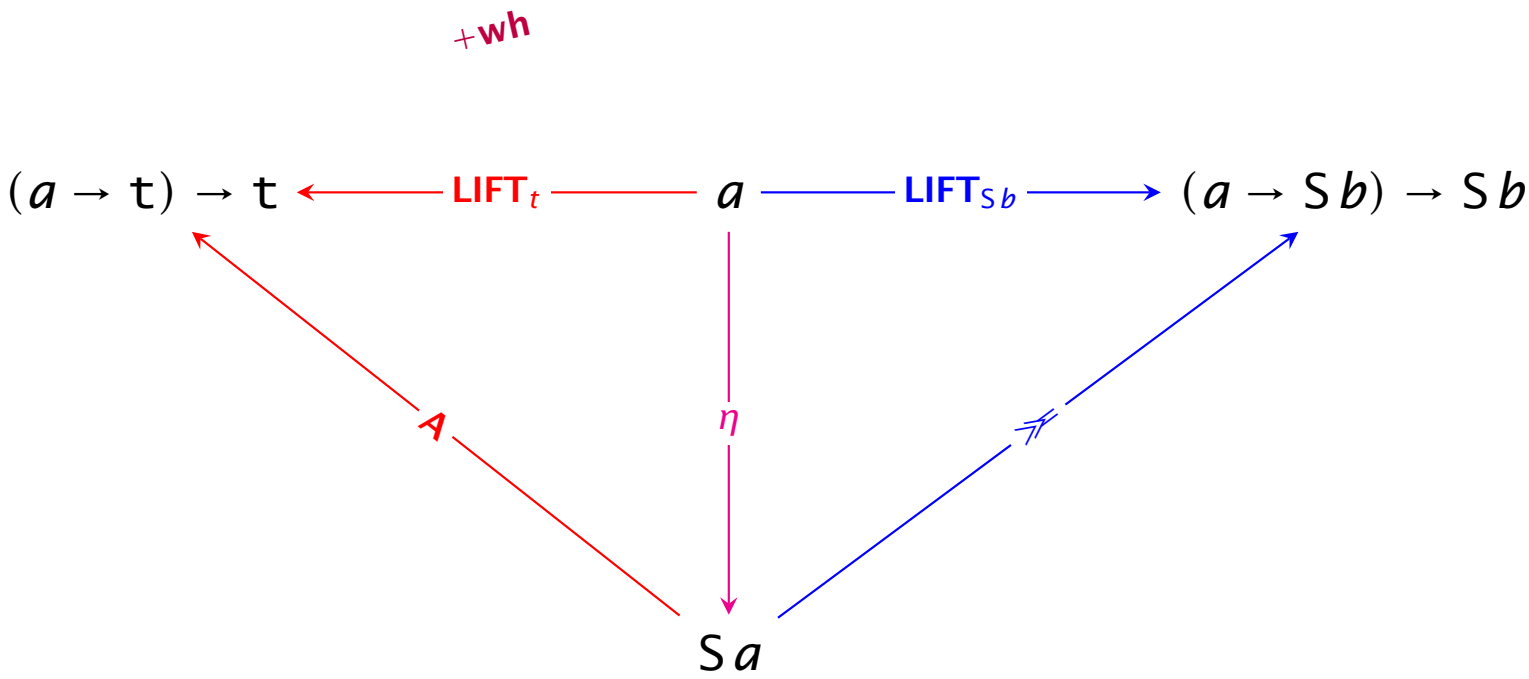
Instead of shifting generalized quantifiers into things that scope over and return alternatives, why not shift sets directly?

If you choose to go that route, you'll end up with two shifters:

$$\eta :: a \to \mathsf{S}\, a \qquad \gg\!= :: \mathsf{S}\, a \to (a \to \mathsf{S}\, b) \to \mathsf{S}\, b$$
$$\eta := \lambda p.\, \{p\} \qquad \gg\!= := \lambda m.\, \lambda f.\, \bigcup_{x \in m} f\, x$$

To emphasize, for any m, $m^{\gg\!=}$ is equivalent to $+wh(\mathbf{A}\, m)$. So instead of mapping GQs into things that scope over sets, we directly map sets into things that scope over sets.

The Partee (1986) triangle++



Exploring island-insensitivity

An apparent problem

Like Karttunen (1977), Cresti (1995), and many others, we propose to analyze the grammar of alternatives via an inherently **scopal** mechanism.

- The 'alternative-generating' expression (the indefinite, or *wh*) needs to take scope to do its thing.

Is this a problem?

1. If [a rich relative of mine dies], I'll inherit a house. $^{\checkmark}\exists \gg$ **if**

The all-encompassing $\gg=$

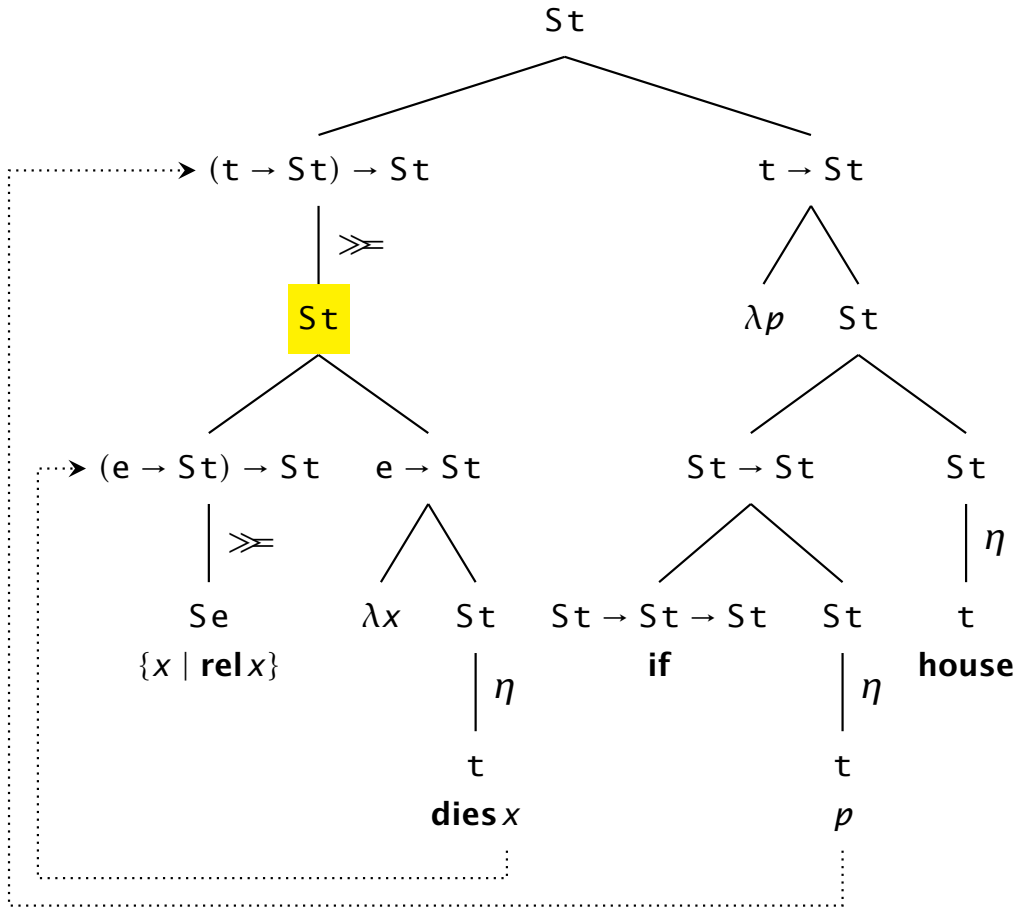
Remember that $\gg=$ is defined *polymorphically*. It can apply to any set of alternatives, whatsoever.

What happens if we $\gg=$-shift the *island*?

$$\begin{aligned}\{\mathbf{dies}\,x \mid \mathbf{rel}\,x\}^{\gg=} &= \lambda f.\bigcup_{p\in\{\mathbf{dies}\,x\mid\mathbf{rel}\,x\}} f\,p \\ &= \lambda f.\bigcup_{x\in\mathbf{rel}} f\,(\mathbf{dies}\,x)\end{aligned}$$

Lordy, it's like the indefinite's alternatives have been sifted out! The thing fed to f is... the rest of the island!

A basic derivation



How about two islands?

The upward scope of indefinites is *unbounded*. No matter how many islands intervene, the indefinite can acquire maximal scope.

So, for example, if we embed the indefinite two (scope) islands deep, it's still possible to hear it as taking maximally wide scope.

1. John thought that [if [a rich relative of his died], he'd get a house].

The trick generalizes

Repeating our example:

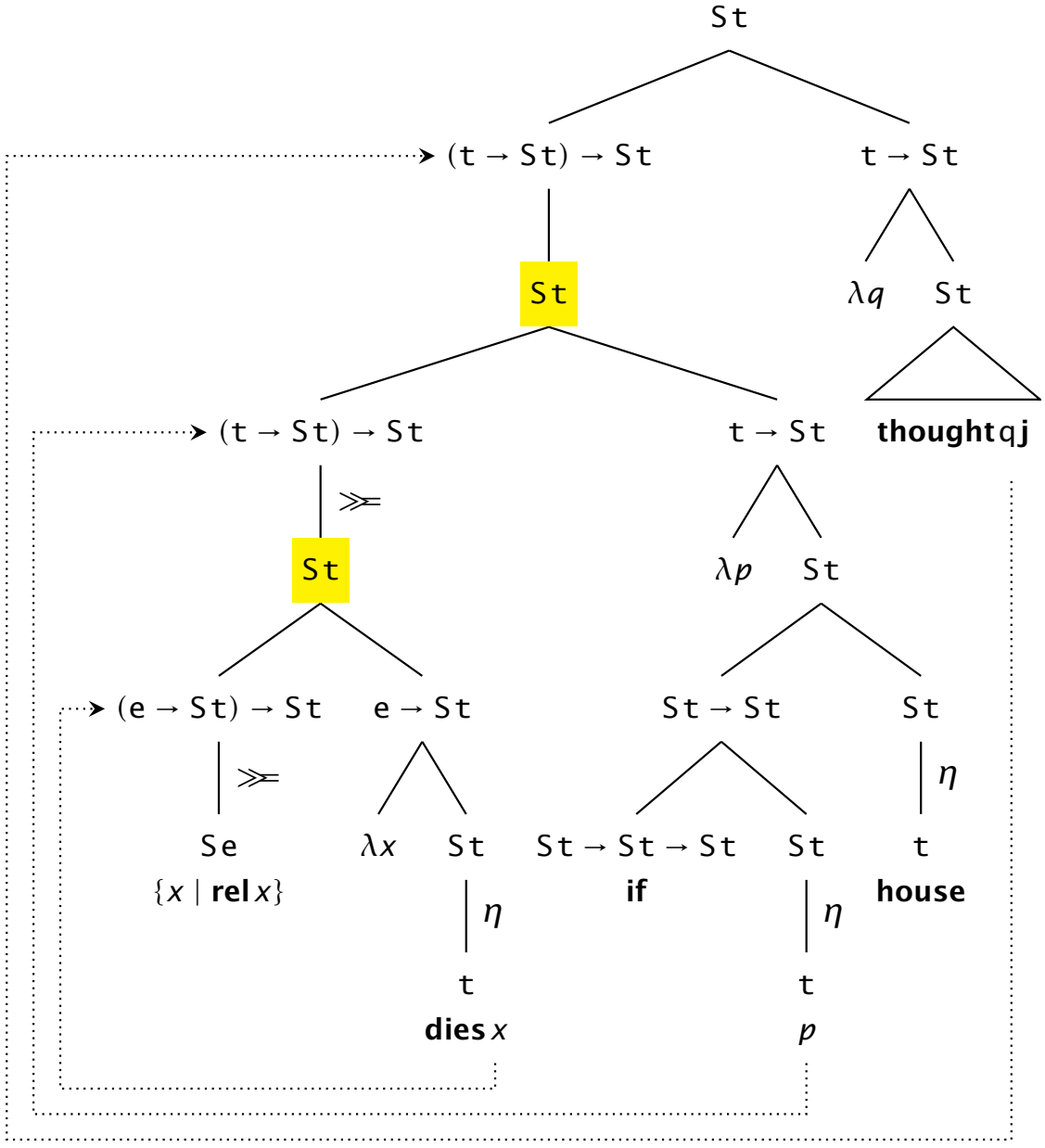
1. John thought that [if [a rich relative of his died], he'd get a house].

Remember: we have *already* derived a meaning for the conditional, and it's another set of propositions. So we are free to $\gg=$-shift this!

$$\begin{aligned}\{\mathbf{dies}\, x \mid \mathbf{rel}\, x\}^{\gg=} &= \lambda f.\bigcup_{p \in \{\ldots \mid \mathbf{rel}\, x\}} f\, p \\ &= \lambda f.\bigcup_{x \in \mathbf{rel}} f\,(\ldots)\end{aligned}$$

Again, it's like sifting the indefiniteness out of the island, and feeding all of the propositional chaff to f.

Here's a derivation

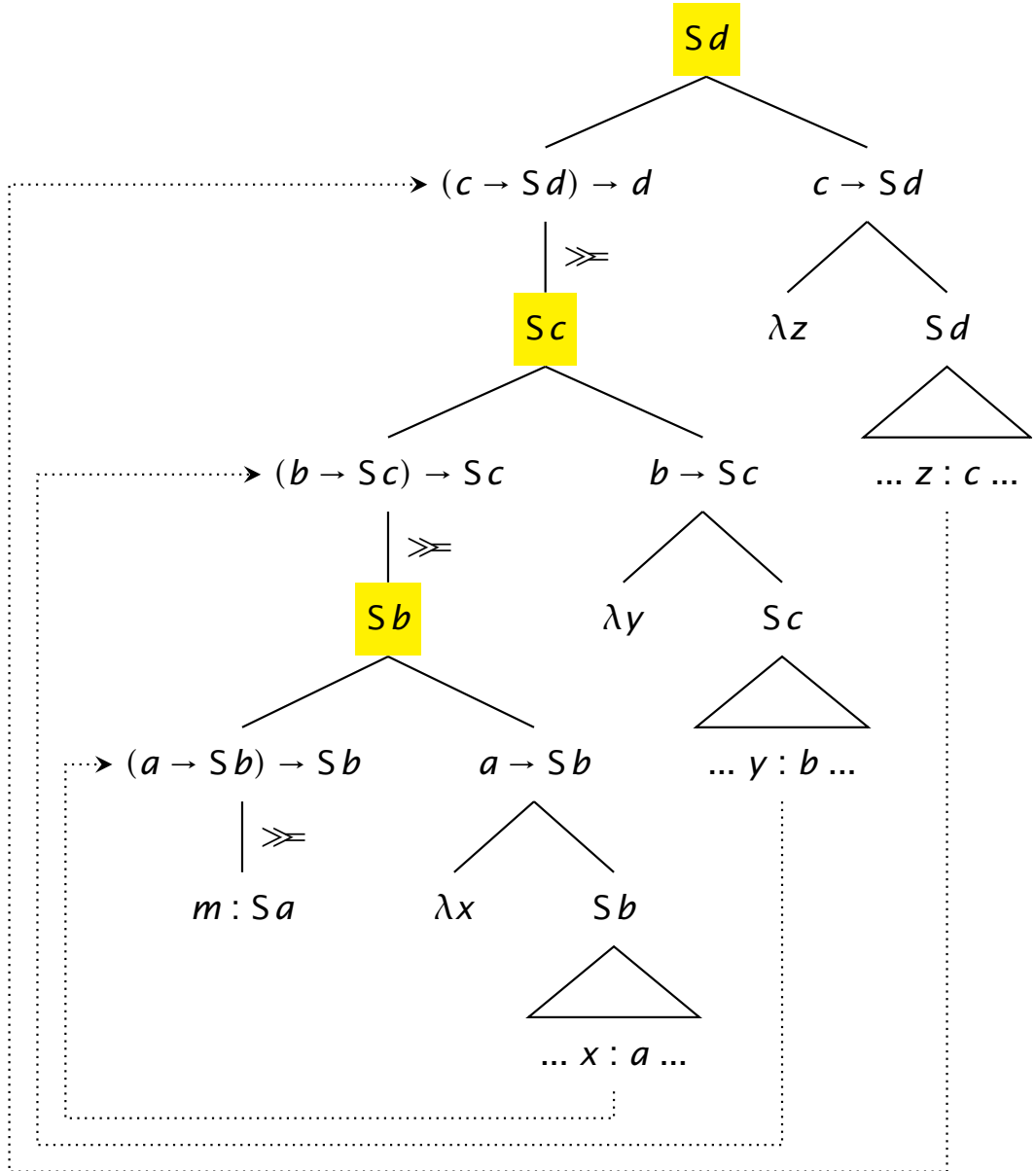


Iterated island-scoping

So whenever we wanna scope something out of an island, we don't actually have to do so! We can just move to the island's edge, and then move that to the next island's edge.

And this process can continue indefinitely.

Iterated island-scoping, schematically



The generality of the trick

You can always scope to the edge of an island. That doesn't require leaving the island.

And the island can always take scope, if applicable to the edge of the next higher-up island.

And this process can continue indefinitely.

Associativity

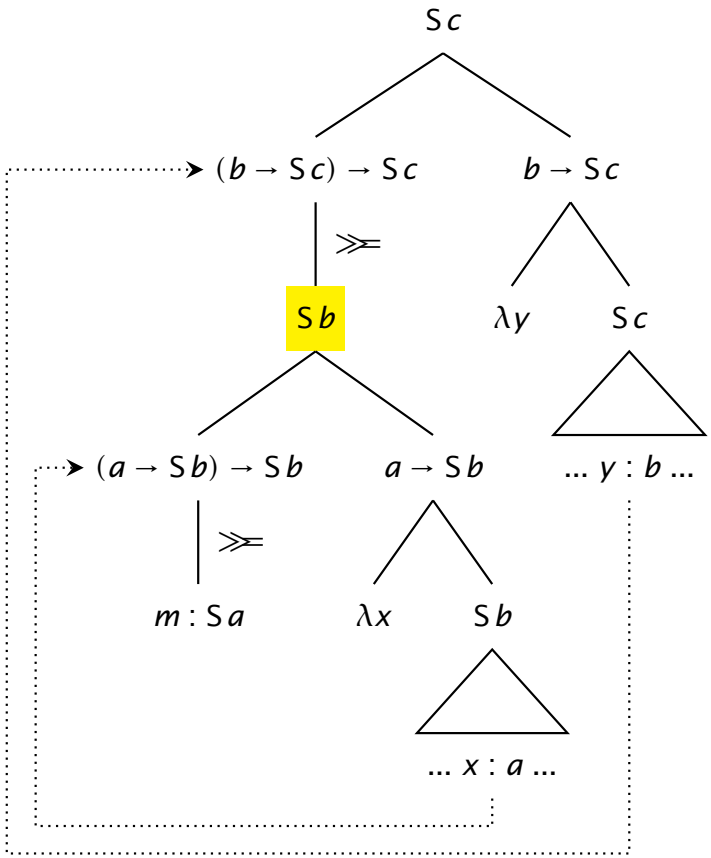
The reason this works is that $\gg=$ obeys a kind of **Associativity**:

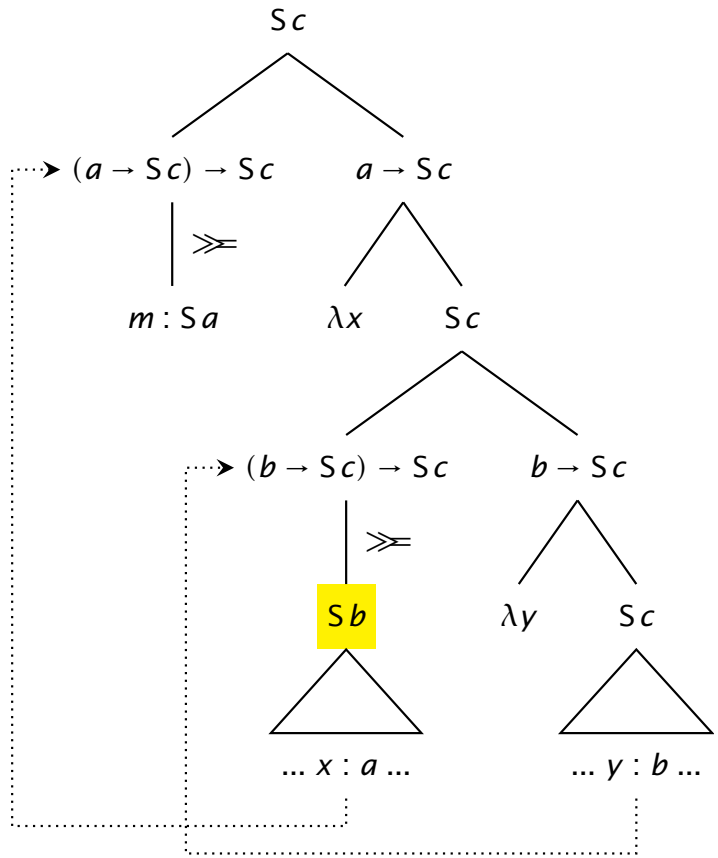
$$(m \gg= \lambda x.\, f\, x) \gg= g = m \gg= (\lambda x.\, f\, x \gg= g)$$

Exercise: prove that this holds for our $\gg=$.

Associativity law in tree form

The import is clearer if we present **Associativity** in tree form:





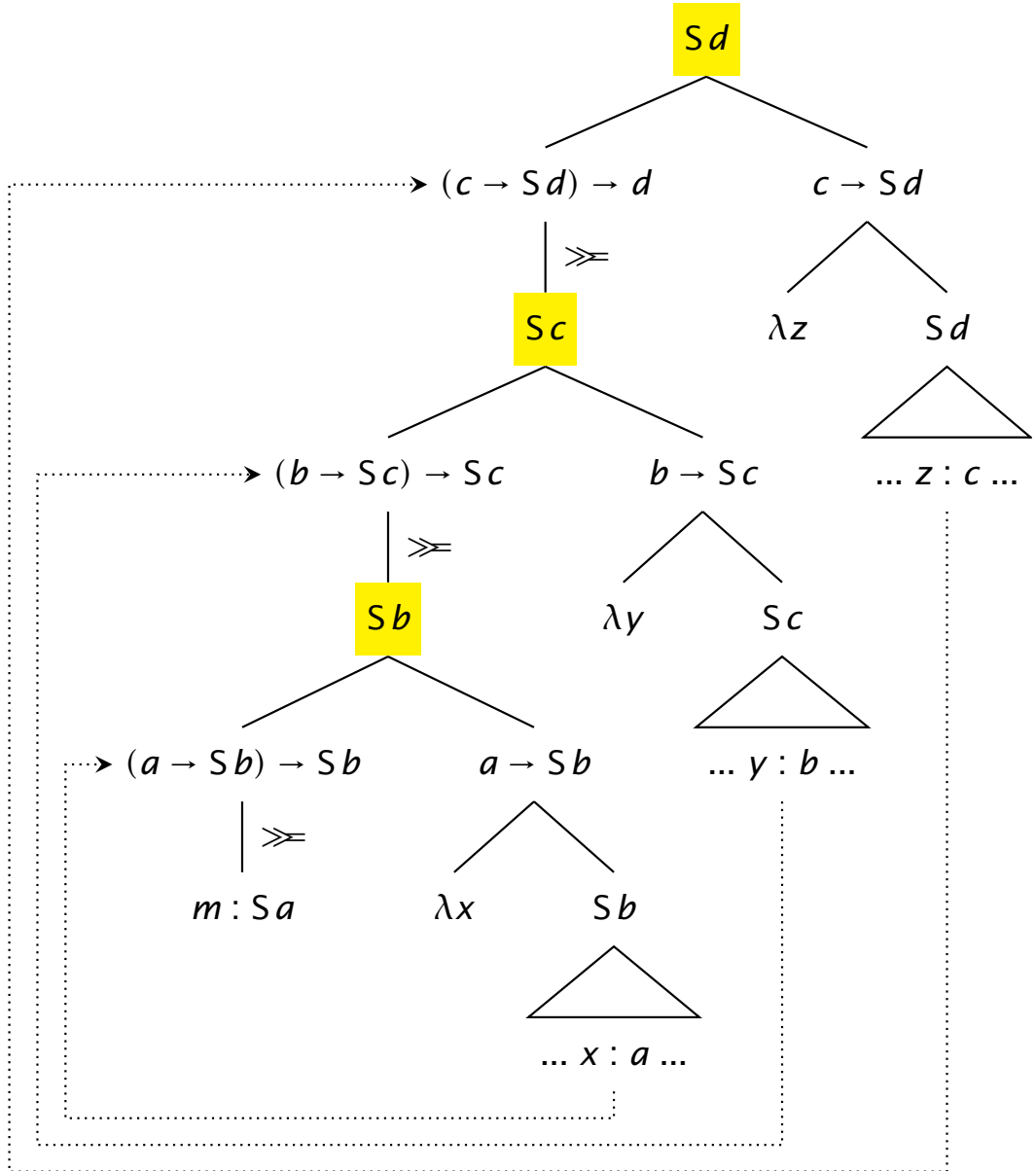
Pied-piping

The process that we appeal to here is an instance of a more general process commonly called **pied-piping**:

1. Whose mother did you see _?
2. *Who did you see _'s mother?

In principle, the *wh* word (*who*) is the only thing that needs to move out for questions (cf. Karttunen 1977). But because this movement is ungrammatical (the DP is an *island*), the whole phrase moves.

Iterating pied-piping



Bavarian German

Heck (2008), citing Felix (1983):

1. Das ist die Frau, [die$_i$ wenn du t_i heiratest] bist du verrückt.
   this is the woman who if you marry are you crazy
   'This is the woman that you are crazy if you marry her.'

2. *Das ist die Frau, die$_i$ du verrückt bist [wenn du t_i heiratest].
   this is the woman who you crazy are if you marry

[Is this contrast replicated in English?]

Finnish

The situation is even more striking in Finnish (Huhmarniemi 2012). Here is the canonical word order when you modify a VP with a PP (V-P-Obj):

1. Pekka näki Merjan [kävellessään [kohti puistoa]].
   Pekka saw Merjan walk towards park
   'Pekka saw Merja when he was walking towards a/the park.'

But here is how it looks when you try to form a with the Obj:

2. [[Mitä$_i$ kohti t_i]$_j$ kävellessään t_j]$_k$ Pekka näki Merjan t_k?
   What towards walk Pekka saw Merjan
   'What was Pekka walking towards when he saw Merja?'

You get the mirror-image word order!

This kind of movement, generally

Is called **roll-up** or (even better) **snowballing** pied-piping.

Overt and scopal (covert) forms of it are appealed for a variety of languages. We've already seen Bavarian German and Finnish.

Other examples include Gbe (overt, Aboh 2004), French (covert, Moritz & Valois 1994), and DP-internal word order (overt, Cinque 2005).

And maybe even English?

English word order doesn't really make it possible to test this, but it's at least conceivable that **recursive pied piping** involves snowballing pied-piping. That is, the following...

1. Whose brother's mother's father did you see?

Might actually be analyzable as the following:

2. [[[Who$_i$ t_i's brother]$_j$ t_j's mother]$_k$ t_k's father]

Applicative instance, derived as a theorem

$$
\begin{aligned}
m \gg\!= \lambda f.\, n \gg\!= \lambda x.\, \eta\,(f\,x) &= m \gg\!= \lambda f.\, n \gg\!= \lambda x.\, \{f\,x\} \\
&= m \gg\!= \lambda f.\, \bigcup_{x \in n} \{f\,x\} \\
&= \bigcup_{f \in m} \bigcup_{x \in n} \{f\,x\} \\
&= \{f\,x \mid f \in m, x \in n\}
\end{aligned}
$$

Does this look familiar?

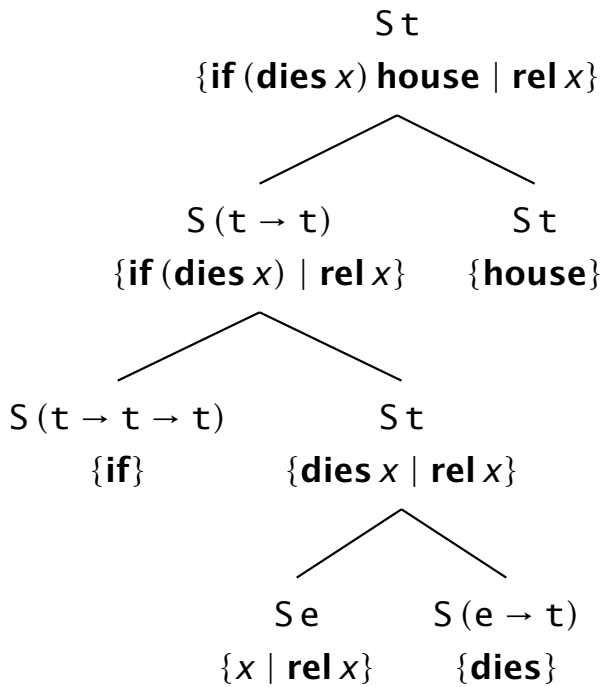
Alternative semantics and binding

Reminder

Alternative-semantic composition is point-wise composition:

$$\textbf{Combine}^{+}(l, r) := \{\textbf{Combine}(l', r') \mid l' \in l, r' \in r\}$$

Refresher: exceptional scope



A reminder about unselectivity

Recall that alternative semantics is fundamentally **unselective**. No matter how many indefinites are on an island, the meaning of the island will always be a flat set of alternatives, type $\mathtt{St}$.

Getting binding in the mix

We'd like to do binding alongside alternatives. How should this go?

Assignment-sensitivity: extracting values at assignments.

$$\mathbf{Combine}^{+}(l, r) := \lambda g.\mathbf{Combine}(l\,g, r\,g)$$

Alternatives: point-wise composition.

$$\mathbf{Combine}^{+}(l, r) := \{\mathbf{Combine}(l', r') \mid l' \in l,\, r' \in r\}$$

Enriching $\mathbf{Combine}^{+}$ directly

Defining a method of *lifting* an enriched combination operation:

$$\mathbf{Combine}^{+_{g\to}}(l, r) := \lambda g.\, \mathbf{Combine}^{+?}(l\,g, r\,g)$$

$$\lambda g.\, \mathbf{Combine}^{+\{\}}(l\,g, r\,g) = \lambda g.\, \{\mathbf{Combine}(l', r') \mid l' \in l\,g,\, r' \in r\,g\}$$

η here is $\eta^{g\to} \circ \eta^{\{\}} = \lambda x.\, \lambda g.\, \{x\}$

Going in the other direction

It's also straightforward to do the other layering:

$$\mathbf{Combine}^{+\{\}}\,(l, r) := \{\mathbf{Combine}^{+?}\,(l', r') \mid l' \in l, r' \in r\}$$

If you wrap this around assignment-sensitivity you get:

$$\{\mathbf{Combine}^{+g\to}\,(l', r') \mid l' \in l, r' \in r\} = \{\lambda g.\,\mathbf{Combine}\,(l'\,g, r'\,g) \mid l' \in l, r' \in r\}$$

η here is $(\eta^{\{\}} \circ \eta^{g\to})\,x = \{\lambda g.\,x\}$

Comparing the two

Our two operations side-by-side:

$$\lambda g.\,\{\textbf{Combine}\,(l', r')\mid l' \in l\,g,\, r' \in r\,g\}$$

$$\{\lambda g.\,\textbf{Combine}\,(l'\,g, r'\,g)\mid l' \in l, r' \in r\}$$

Along with the corresponding η's:

$$\lambda g.\,\{x\} \qquad\qquad \{\lambda g.\,x\}$$

A question of layering

Is one of these layers preferable to the other?

How would we know?

Let's try to make binding happen

Binding in standard approaches:

$$[\![\lambda_i\ X]\!] = \lambda g.\lambda x.[\![X]\!]\, g^{i \to x}$$

An initial attempt with alternatives:

$$[\![\lambda_i\ X]\!] = \lambda g.\{\lambda x.[\![X]\!]\, g^{i \to x}\}$$

But this has the wrong type! Instead of being a set of functions, its a set of functions into sets(!) (Shan 2004).

A ‘standard’ ‘solution’

Here is one possibility (Hagstrom 1998, Kratzer & Shimoyama 2002):

$$[\![\lambda_i\ X]\!] := \lambda g.\{\lambda x.f\,([\![X]\!]\,g^{i\rightarrow x}) \mid f \in \mathbf{CF}\}$$

. . . Where **CF** is a set of *choice functions*, things of type $\mathrm{S}\,a \rightarrow a$.

Here is an example for [λ_0 t_0 met a linguist]:

$$\{\lambda x.f\,\{\mathbf{met}\,y\,x \mid \mathbf{ling}\,y\} \mid f \in \mathbf{CF}\}$$

The types are right. But is this an acceptable solution?

An equivalence

Introducing a choice function in the abstraction operator in this way is equivalent to attaching a *Skolemized* choice function to the indef:

$$\{\lambda x.\, f\, \{\mathbf{met}\, y\, x \mid \mathbf{ling}\, y\} \mid f \in \mathbf{CF}\} = \{\lambda x.\, \mathbf{met}\, (f_x\, \mathbf{ling})\, x \mid f \in \mathbf{SkCF}\}$$

Over-generation

The following is equivalent to *nobody met every phonologist*:

1. Nobody [λ_0 t_0 met a phonologist].
   $\{\neg\exists x \in \textbf{human} : \textbf{met}\,(f_x\,\textbf{phon})\,x \mid f \in \textbf{SkCF}\}$

The following is equivalent to *nobody submitted every paper she wrote*:

2. Nobody [λ_0 t_0 submitted a paper she$_0$ had written].
   $\{\neg\exists x \in \textbf{human} : \textbf{subd}\,(f_x\,(\lambda y.\,\textbf{paper}\,y \wedge \textbf{wrote}\,x\,y))\,x \mid f \in \textbf{SkCF}\}$

Under-generation

We'd like to derive an exceptional-scope reading for (1), but we're not able to. Because f_x varies with *everybody*, so does the choice of expert.

1. Everybody [λ_0 t_0 loves when [a famous expert cites him$_0$].
   $\{\forall x \in \textbf{human} : \textbf{loves.when}\,(\textbf{cites}\,x\,(f_x\,\textbf{exp})) \mid f \in \textbf{SkCF}\}$

Going the other way

If we use a sets-over alternatives layering we *can* define abstraction:

$$[\![\lambda_i\, X]\!] := \{\lambda g.\, f\, g^{i \to x} \mid f \in [\![X]\!]\}$$

Bound-into indefinites

The problem for this approach is: how many functions should be in the set associated with *a paper she*$_0$ *had written*?

Shouldn't this depend on how *she*$_0$ is resolved? Seems so. But layering alternatives over assignments prevents this. We have no way to know, when we construct the initial set, how many things should be in it.

A solution?

Here's a possible solution:

$$[\![\text{a paper she}_0 \text{ wrote}]\!] := \{\lambda i.\, f\,(\lambda x.\, \mathbf{paper}\, x \wedge \mathbf{wrote}\, x\, i_0) \mid f \in \mathbf{CF}\}$$

But this isn't really a solution. The alternatives are totally dissociated from binding, so there's nothing to prevent wide-scope readings of:

1. No candidate$_x$ submitted a paper she$_x$ had written.

A Karttunen-esque treatment?

A binding monad

Suppose we were going to define a ‘monad instance’ for binding. How would that look?

The type constructor is easy to construct:

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And we already know what η would have to be:

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And we already know what η would have to be:

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What about $\gg=$?

We know it has to have the type $\mathsf{G}\,a \to (a \to \mathsf{G}\,b) \to \mathsf{G}\,b \ldots$

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$$m \gg= f := \lambda g.\, f\,(m\,g)\,g$$

So that is our monad for binding!

$$\eta :: a \to \mathsf{G}\,a \qquad\qquad \gg= :: \mathsf{G}\,a \to (a \to \mathsf{G}\,b) \to \mathsf{G}\,b$$
$$\eta := \lambda x.\, \lambda g.\, x \qquad\qquad \gg= := \lambda m.\, \lambda f.\, \lambda g.\, f\,(m\,g)\,g$$

Is it a monad?

Well, the η and $\gg=$ operations have the right shape. So all we need to do is check that it obeys **Left** and **Right identity**, along with **Associativity**.

Let's just check that **Left identity** is satisfied:

$$(\eta\, x) \gg= f =$$

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I won't subject you to the rest of them here, but it's actually not too difficult to prove them on your own. Exercise: try it!

Deriving the applicative instance

$$m \gg\!= \lambda f.\, n \gg\!= \lambda x.\, \eta\,(f\,x) = \lambda g.\, m\,g\,(n\,g)$$

Does this remind you of anything?

Combining two monadic regimes

A tale of 2 monads

So we have two monads, one for alternatives. . . .

$$\eta :: a \to \mathsf{S}\,a \qquad \gg\!= :: \mathsf{S}\,a \to (a \to \mathsf{S}\,b) \to \mathsf{S}\,b$$
$$\eta := \lambda p.\,\{p\} \qquad \gg\!= := \lambda m.\,\lambda f.\,\bigcup_{x \in m} f\,x$$

. . . And one for binding:

$$\eta :: a \to \mathsf{G}\,a \qquad \gg\!= :: \mathsf{G}\,a \to (a \to \mathsf{G}\,b) \to \mathsf{G}\,b$$
$$\eta := \lambda x.\,\lambda g.\,x \qquad \gg\!= := \lambda m.\,\lambda f.\,\lambda g.\,f\,(m\,g)\,g$$

A choice

We might wish to derive a *combined* monad so that we might walk and chew gum at the same time.

But as with alternative semantics, this presents us with a choice. Do we layer binding around alternatives, or alternatives around binding?

$$\mathsf{GS}\,a ::= g \to \mathsf{S}\,a \qquad \mathsf{SG}\,a := \mathsf{S}\,(g \to a)$$

For next time

We'll take up these issues in more detail. I'll ask you to read my hot-of-the-presses ms. 'The scope of alternatives', which I'll email you.

In the meantime, you might start playing around with GS and SG. Can you define monadic 'instances for them'? For one, but not the other?

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