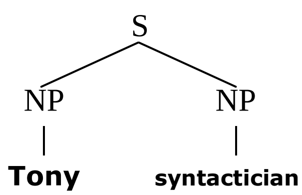
Beyond Verbs

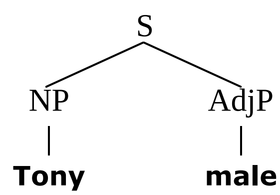
LING 553

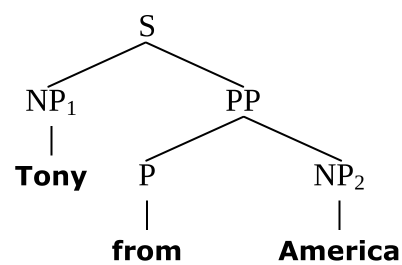
September 24, 2008

1. NOUNS, ADJECTIVES, PREPOSITIONS

1.1. Why this is easy



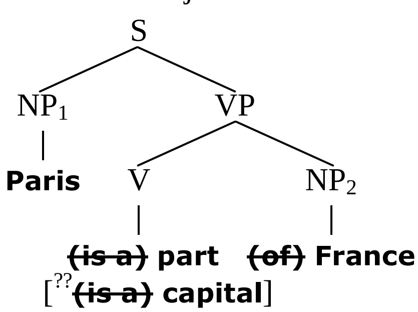


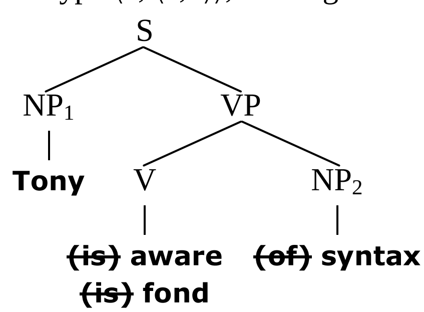


...then we're practically done.

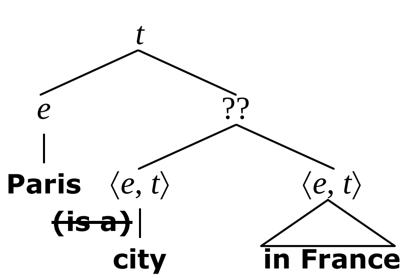
- ⟦**syntactician**⟧ = $\lambda x : x \in D_e$. x is a syntactician
- ⟦**male**⟧ = $\lambda x : x \in D_e$. x is male
- ⟦**from**⟧ = $\lambda x : x \in D_e$. [$\lambda y : y \in D_e$. y is from x]

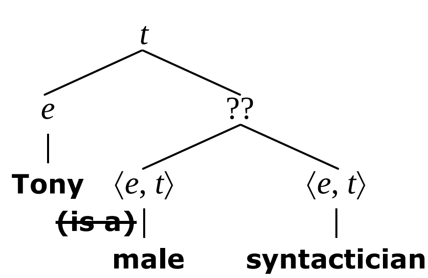
Nouns and adjectives are just like intransitive verbs; prepositions are just like transitive verbs. In fact, some nouns and adjectives are "transitive", i.e. have type $\langle e, \langle e, t\rangle\rangle$, if we ignore **of**:[1]





1.2. Why this gets hard





[1] Are there "intransitive" prepositions? This is clearly a matter of some contention, so we'll gloss over it, noting only that if there were, they would have type $\langle e, t\rangle$ like "intransitive" verbs, nouns, and adjectives.

The problem is, we have one rule of composition, and it doesn't apply here, because the daughters of the nodes marked "??" don't have types $\langle \sigma, \tau \rangle$ and σ. We know we *want* them to denote $\langle e, t \rangle$ objects. So what do we do?

1.2.1. A few sentences we won't consider [yet]

(1) **a syntactician came into the room**

We want **a syntactician** to denote something of type *e* here, presumably. We'll say for now that this **a** can't actually be ignored, and hopefully we can come back and unify everything.

(2) **a physicist is [necessarily] a mathematician**

If we ignore both instances of **a**, then this looks like it ought to be a combination of two $\langle e, t \rangle$-type objects, ⟦**physicist**⟧ and ⟦**mathematician**⟧, though in this case we apparently want something of type *t*. For this example, let's note that the above caveat holds; and also that there's something more going on here than just a fact about the sets: this sentence seems to appeal to a kind of Platonic idea of "a physicist", or to the generic physicist, or...something.

(3) **Tony is a male bearded tenured syntactician**

In fact, we *will* want to consider this sentence quite soon...

> ***A digression on the scientific method***
>
> Something that can be all too common, in all fields of science but certainly in linguistics: take a set of data, D. Devise a theory based on D. Show that your theory accounts for everything in D. Declare your theory a success.
>
> That's just plain bad science. Of *course* a theory developed on the basis of D will explain D; anyone can do that. What you want is to develop a theory based on D, and then look at a new (or larger) set of data, D′, to see whether your theory can handle facts it wasn't designed to.
>
> So we'll put this sentence on hold, and after we develop a theory, we'll come back and see whether that theory accounts for it.

1.3. Two competing intuitions

The immediate intuition about **male syntactician** seemed to be the following:

- We need a new rule of composition! It will...
  - take two daughters of some type and return something of the same type [Lydia]
  - give the set intersection of the two daughter nodes [Dimka]

- Consequence: we need to double our stock of composition rules. Suddenly, *contra* Frege, not everything is Function Application.

We'll call that Approach I for now. Before we spell it out, we should note that there's also an Approach II:

- Adjectives like ⟦**male**⟧ have type $\langle\langle e, t\rangle, \langle e, t\rangle\rangle$.

- Consequence: there's still just function application, but we might need **male** to be ambiguous to account for **Tony is male**, or we might need a more complex meaning for **is**.[2]

In general in the *type-driven* semantics we're doing, the composition is determined by (a) the semantic types, (b) the syntax, and (c) the composition rules. So when we hit a clash like we do here, trying to combine $\langle e, t\rangle$ with $\langle e, t\rangle$, we can:

- Change (a). For instance, we can discard our belief that adjectives have type $\langle e, t\rangle$, and instead say that, for FA to work, they have a type that takes noun denotations—i.e., $\langle e, t\rangle$s—as arguments and returns the $\langle e, t\rangle$ denotations we want for the parent nodes. That is, they have type $\langle\langle e, t\rangle, \langle e, t\rangle\rangle$.

- Change (b). In this case, that won't work very well, because syntacticians will insist on trees like the above and because there's not an obvious alternative that would work better. (Perhaps: the syntax is really **Tony ~~is~~ male and ~~a~~ syntactician**, with the **and a** deleted? This won't turn out to work, but it's the kind of thing we might consider.)

- Change (c). That was Approach I, which was the immediate intuition of at least some of the class. But don't forget there are other approaches.

[2] Insert Clintonian "depends on what the meaning of 'is' is" reference here.

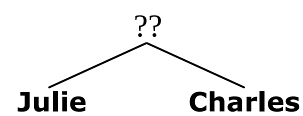
2. SPELLING OUT THE APPROACHES

2.1. Approach I: New Composition Rule

Add a rule that we'll call **PREDICATE MODIFICATION**. It'll need to say that the node has the same type as its daughters, and that its meaning is the set intersection of the daughters.[3]

(4) **Predicate Modification (First Draft)**
If a node α has daughters β, γ, and $[\![\beta]\!]$ and $[\![\gamma]\!]$ both have the semantic type σ, then $[\![\alpha]\!]$ has type σ, and $S_{[\alpha]} = S_{[\beta]} \cap S_{[\gamma]}$.

NOTE ON NOTATION: in class, I used $\underline{\boldsymbol{\varphi}}$ to mean "the set characterized by function φ". I'm going to use $\mathbf{S}_\varphi$ here, because it can be hard to tell what's underlined, especially with brackets involved (e.g., $\underline{[\![\beta]\!]}$), and crucially what we have here is $S_{[\beta]}$, "the set characterized by the function that is the denotation of word β". (And not $[\![S_\beta]\!]$, "the denotation of the set characterized by the function that is the word β", which is meaningless twice over.)



This definition runs into some immediate problems. For instance, it assigns to the tree at the right a meaning something like "the intersection of Julie and Charles", which is deeply weird.

One reaction seemed to be, "that's what we'd want for **Julie and Charles** anyway." But, well, no, for a number of reasons. First, we might actually want something like "union" and not "intersection", though the union of Julie and Charles is, perhaps, their son Russell. Second, even if we get it to mean "the set containing both Julie and Charles", we really don't want **Julie and Charles went to the movies** to mean that some set went to the movies. In any case, **and** is clearly contributing something here.

What we need to do, as we rewrite (4), is ensure that we don't let things with type e sneak in. So we could limit it to type $\langle e, t\rangle$, though that seems too specific. Or we could limit it to type $\langle \sigma, \tau\rangle$, i.e. to functions, though not all of those are going to work too well with (the function-based equivalent of) set intersection. Instead, we'll take a middle ground and limit it to objects with type $\langle \sigma, t\rangle$ (in practice, though, we'll practically always use $\sigma = e$).

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[3] This uses Dimka's idea that the meaning of this interpretation rule is "set intersection"; that meshed nicely with Yanyan's intuition that Approach I involved "sets", and Approach II involved "functions". But remember that sets and (certain) functions are really the same thing. We could, for instance, write Function Application in set notation:

> If we have a node α, and its daughters are β and γ, where $[\![\beta]\!]$ is a set of things of type σ and $[\![\gamma]\!]$ is something with type σ, then $[\![\alpha]\!]$ = TRUE iff $[\![\gamma]\!] \in S_{[\beta]}$.

though that only works if the result is a truth value.

Because it's going to take two $\langle \sigma, t \rangle$ things and produce something of type $\langle \sigma, t \rangle$, the result will have the form $\lambda x : x \in D_\sigma$. [...], involving the meanings of β and γ. And what we want, informally, is for β and γ to both be true of *x* (e.g., both "male" and "syntactician" are true of Tony). What we end up with is:

(5) **Predicate Modification (Interpretation Rule #2)**
If a node α has daughters β, γ, and ⟦β⟧ and ⟦γ⟧ both have the semantic type $\langle \sigma, t \rangle$, then ⟦α⟧ also has type $\langle \sigma, t \rangle$, and $[\![\alpha]\!] = [\lambda x : x \in D_\sigma \,.\, [\![\beta]\!](x) \text{ and } [\![\gamma]\!](x)]$.

i.e., $[\![\alpha]\!](x)$ = TRUE iff $[\![\beta]\!](x)$ = TRUE and $[\![\gamma]\!](x)$ = TRUE.

So that's our new composition rule, and ⟦**male**⟧ = $[\lambda x_e \,.\, x$ is male], type $\langle e, t \rangle$.

2.2. Approach II: New Type for Adjectives

At this point, it's relatively easy to see what $\langle e, t \rangle$ meaning we want the adjective to output: it should incorporate the conjunction. So:

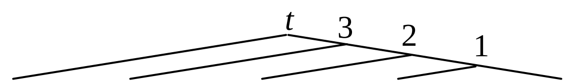
(6) ⟦**male**⟧ = $[\lambda P_{\langle e, t \rangle} \,.\, [\lambda x_e \,.\, P(x)$ and x is male]]

Of course, the downside of this approach is that ⟦**Tony ~~is~~ male**⟧ is now a combination of the type-*e* denotation of **Tony** and the type-$\langle\langle e, t \rangle, \langle e, t \rangle\rangle$ denotation of **male**. Unless we have two lexical entries, $\textbf{male}_1$ and $\textbf{male}_2$, though we've seen that problem before.

3. DECIDING BETWEEN I AND II

3.1. Evidence from stacked adjectives?

Earlier, we set aside:



	Tony	**male**	**bearded**	**tenured**	**syntactician**
I:	e	$\langle e, t\rangle$	$\langle e, t\rangle$	$\langle e, t\rangle$	$\langle e, t\rangle$
II:	e	$\langle et, et\rangle$	$\langle et, et\rangle$	$\langle et, et\rangle$	$\langle e, t\rangle$

Now, we'll get the following, speaking informally:

	Approach I	Approach II
1	**tenured** + **syntactician** =	**tenured** + **syntactician** =
	true iff ⟦**tenr'd**⟧(x) and ⟦**synt.**⟧(x) =	true iff [x is tenr'd and ⟦**synt.**⟧(x)] =
	true iff [x is tenr'd] and [x is a synt.]	true iff [x is tenr'd]and [x is a synt.]]
2	**bearded** + [1] =	**bearded** + [1] =
	true iff ⟦**brdd**⟧(x) and [1] =	true iff [x is brdd and [1]] =
	true iff [x is brdd and [x is tnrd and x is a synt]]	true iff [x is brdd and [x is tnrd and x is a synt]]
	etc.	etc.

In other words, we'll get the same ultimate result from both approaches: true if and only if Tony is male and bearded and tenured and a syntactician. That's not surprising, since we built the "A and B" meanings into both Predicate Modification and the higher denotation of adjectives.

(Feel free to verify for yourself that both approaches have the same result.)

Result: tie. But it's good to know that the theories don't crash and burn here.

3.2. Evidence from privative adjectives?

Which theory can explain **Bill Clinton ~~is a~~ former president**?

- Predicate Modification: no chance at all. ⟦**former**⟧ will have to be an $\langle e, t\rangle$ function, that is, true of an individual just in case he's former. In set terms, Bill Clinton would have to be in the set of things that are former. That's nonsense.

- $\langle\langle e, t\rangle, \langle e, t\rangle\rangle$ meanings: perhaps a chance? ⟦**former**⟧ takes ⟦**president**⟧ and returns the set of former presidents. That is, ⟦**former**⟧ = $\lambda P_{\langle e, t\rangle} . \lambda x_e$. [....]

But the problem is, what can go in as the truth conditions? In fact, nothing can: you can't derive the set of former presidents from the set of presidents. cf Heim and Kratzer:

- ⟦**resident of 13 Green Street**⟧ = {fred, mary}
  ⟦**lover of John's**⟧ = {fred, mary}

  i.e., these denote the same function, call it f, where $f(x) = \begin{cases} \text{TRUE if } x \text{ is Fred or Mary} \\ \text{FALSE otherwise} \end{cases}$.

  But: ⟦**former resident of 13 Green Street**⟧ = ⟦**former**⟧(f), and ⟦**former lover of John's**⟧ = ⟦**former**⟧(f), so these, too, will have to be identical. But it's possible for "Bill is a former resident of 13 Green Street" to be true while "Bill is a former lover of John's" to be false (or vice versa).

In other words, you can get the set of male syntacticians from the set of syntacticians: go through the set, remove anything female. But given a set of presidents, or residents of 13 Green Street, or the like, you can't do anything to derive the former ones.

We end up needing, not an $\langle e, t\rangle$ meaning as the argument of ⟦**former**⟧, but some kind of meaning that incorporates times. Similarly, ⟦**alleged**⟧ doesn't map, say, the set of criminals to the set of alleged criminals; it has to take into account other possibilities besides the actual ones.

Adjectives like **former**, **alleged**, **fake**, **wannabe**, and so forth are called **privative** adjectives. These are adjectives for which "*x* is an Adj. Noun" does not entail "*x* is a Noun".[4]

Result: another tie. Neither predicate modification nor $\langle\langle e, t\rangle, \langle e, t\rangle\rangle$ meanings can account for privative adjectives. So these don't help.

3.3. *More evidence...?*

Some data to consider:

- Olga is a beautiful dancer.
- Caitlin is short. (True, perhaps.)
- Caitlin is a {short/tall} kindergartener. (False, either way.)
- Olivia is a tall kindergartener. (Where Olivia is a kindergartener, and Caitlin's height.)

What are the adjectives doing in these sentences?

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[4] Rough definition of entailment: X entails Y if, whenever X is true, Y <u>must</u> be true, but if X is false, Y may be true or false. For instance, **Sam is a bachelor** entails **Sam is male**; but **Sam is a professor** does not. In the cases considered here: **Tony is a male syntactician** entails **Tony is a syntactician**, but **Tony is a former student at MIT** does not entail **Tony is a student at MIT**.

"X entails Y" is often written X $\vdash$ Y, with a slash through the symbol for "does not entail".