EGG intro semantics week 2

What we talk as if there is

Rob Truswell

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The backbone of formal semantics

- Week 1 has introduced you to some foundational ideas in semantic theory:
  - Compositionality
  - Interpretation relative to a model
  - Truth-conditions (or satisfaction conditions)
  - λ-calculus
- Without those tools, there would be no formal semantics as we know it.
- And yet, from an empirical perspective, they are just tools with which you can construct analyses.
- A huge range of semantic theories develop these ideas in different ways.

The atoms in Montague semantics

- Classical formal semantics *à la* Montague uses these tools to construct a semantic theory within a logical space defined by two primitive domains:
  1. D_e, the individuals;
  2. D_t, the truth values.
- Everything else is a more complex object constructed recusrively on the basis of those domains, through set formation, the ${}^{\cup}/{}^{\cap}$-operators, etc.
- This is an analytical choice, not a necessity. Formal semantics as we know it *doesn't* require this.

Choice points

- Seeing things this way invites a range of questions:
  1. What is an individual (what goes in D_e)?
  2. What role do truth values play in interpretation?
     - 2.1 Broader, loosely related question: what are the units in structured semantic representations?
  3. What else do we need (are D_e and D_t enough)?
- These are some of the big questions in semantics. Like any big questions, they're hard to address directly.
- This week, we're going to look at some empirical work concerning (mainly) event descriptions, and examine its consequences for (mainly) the first and third questions.

Natural language metaphysics

- These questions are related to the research agenda described by Emmon Bach as natural language metaphysics:

  Metaphysics I take to be the study of how things are. It deals with questions like these:
  What is there?
  What kinds of things are there and how are they related?
  Weighty questions, indeed, but no concern of mine as a linguist trying to understand natural language. Nevertheless, anyone who deals with the semantics of natural language is driven to ask question that mimic those just given:
  What do people talk as if there is?
  What kinds of things and relations among them does one need in order to exhibit the structure of meanings that natural languages seem to have?

Natural language metaphysics

- These questions are not easily answered.
- We won't try to answer them.
- We'll be working in a more exploratory, conditional way: "Here's some circumstantial evidence for P. So maybe P. And if you assume P, then you'll want to think about $Q_{\{1,\ldots,n\}}$".
- An initial example: denotations of plurals and mass nouns. We'll contrast a theoretically parsimonious account (reusing as much as possible) with an account which builds more structure into the domain of individuals.
- Don't expect one account to win! They both work pretty well. They just do so in different ways.

An example: Plurals

- By now, we're used to something like this:
  - $D_e = \{a, b, c, d\}$
  - $[\![\text{dog}]\!] = \{a, b, c\}$
  - $[\![\text{smokes}]\!] = \{a, b, d\}$
  - $[\![\text{dog who smokes}]\!] = \{a, b\}$
  - $[\![\text{Fido}]\!] = a$
  - $[\![\text{Rover}]\!] = b$
- What about *Fido and Rover*? Or *Dogs who smoke*?
- It seems unlikely that $[\![\text{dogs who smoke}]\!] = \{a, b\}$, because Fido isn't dogs who smoke and Rover isn't dogs who smoke.
- We already have one device for reasoning with collections of individuals, namely set formation. So maybe:
  - $[\![\text{Fido and Rover}]\!] = \{a, b\}$
  - $[\![\text{dogs who smoke}]\!] = \{\{a, b\}\}$

Plurals as sets

- This parsimonious approach to theoretical apparatus generates type-theoretic complexity.
  - *Dog* is of type $\langle e, t\rangle$. *Dogs* is of type $\langle\langle e, t\rangle, t\rangle$ (its denotation might be $\{\{a, b\}, \{a, c\}, \{b, c\}, \{a, b, c\}\}$: the set of sets of dogs).
  - $Smokes_{sg}$ is of type $\langle e, t\rangle$. $Smoke_{pl}$ is of type $\langle\langle e, t\rangle, t\rangle$.
- It doesn't matter that we're using sets of individuals for yet another purpose: singular common nouns and intransitive verbs behave differently, and we rely on the syntax to tell us that. Same with groups as denotations of plural NPs.

Distributive and collective predication

- It might even be a good thing. We can leverage the type-theoretic distinction between singular predicates and plural predicates to account for collective and distributive predication.
  - *Lift that piano* is of types $\langle e, t\rangle$ and $\langle\langle e, t\rangle, t\rangle$, because you can do it individually or together.
  - *Gather* is only of type $\langle\langle e, t\rangle, t\rangle$, because you can't do it on your own.
  - *Die* is only of type $\langle e, t\rangle$, because you can't do it collectively.
- We can start to envisage a family of operations relating the singulars and the plurals, the distributive and collective predications.
  - If a predicate p is of type $\langle e, t\rangle$ p_{Col} is a predicate of type $\langle\langle e, t\rangle, t\rangle$. For a plural denotation X, $p_{Col}(X) = 1$ iff $\forall x \in X.p(x) = 1$.
  - If a predicate p is of type $\langle e, t\rangle$ and X is a plural denotation (type $\langle e, t\rangle$), $Dist(X)(p) = 1$ iff $\forall x \in X.p(x) = 1$.

(Both of these can be improved in lots of ways).

Mass nouns

- English plurals and mass nouns behave similarly in certain ways. Most famously, they can appear as bare arguments.

(1) The swimming pool is full of water/pigeons/#car

- And neither can be (easily) pluralized.

(2) a. #Dogses, furnitures
    b. Waters (= portions of water)

- Sometimes (in the case of "collections"), it kind of makes sense to extend the plural-as-set analysis to mass nouns.
  - $[\![\text{furniture}]\!] = \{X | \forall x \in X . x \text{ is a piece of furniture}\}$
- And you can just about force more canonical mass nouns into this mould.
  - $[\![\text{water}]\!] = \{X | \forall x \in X . x \text{ is a piece of water}\}$

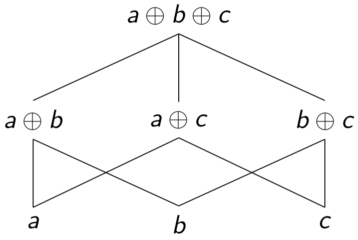
What have we done?

- To capture these similarities between mass nouns and plurals, we've more or less made mass nouns into plurals.
- So the next steps would be to say something about why they're morphologically singular, and about the semantics of words like *piece*.
- These are not trivial: *wooden furniture* can have different properties from the *wood* that it is made of (e.g. you can make new wooden furniture from old wood).
- It can be done (early work along these lines by Terence Parsons and Michael Bennett).
- But there's a persistent hunch that, in doing it, you're no longer being so parsimonious: the heavy lifting comes to be done by nuanced bespoke definitions, not just "plurals and mass nouns denote sets".

Link's alternative

- Godehard Link developed an alternative, based on developing our theoretical understanding of "individual", so that the contents of Link's D_e bear only a distant resemblance to our intuitive understanding of the notion.
- Crucial leading idea: individuals can have other individuals as proper parts.
  - This has to be true, given the role that individuals play in our logic. E.g. London has different properties from Westminster Abbey.
  - And my nose has different properties from me.
- In its full generality, we insist that for every $x, y \in D_e, x \oplus y \in D_e$.
- That generates a structure called a *join atomic semilattice*.

A join atomic semilattice



- We call a, b, and c the *atoms* which generate the lattice.
- Any set of individuals generates such a lattice: if a, b, and c are all the (atomic) dogs in D_e, we can think of the lattice as the (number-neutral) denotation of *dog*.
- The lines represent the (proper) individual part-of relation, $\sqsubset_i$.
- We also get other nice things for free: like a definition of *the dogs* as the element x s.t. $x \in [\![\text{dog}]\!] \wedge \forall y \in [\![\text{dog}]\!].y \sqsubseteq x_i$.

Singulars, plurals, and mass nouns

- We can now (roughly) reconstruct our singular–plural distinction within this lattice: singulars denote atoms, plurals don't.
- For *the dog* to denote, there must be an atom s.t. $x \in [\![\text{dog}]\!] \wedge \forall y \in [\![\text{dog}]\!] . y \sqsubseteq x$. This can only happen if there's only one element in $[\![\text{dog}]\!]$, so we get the uniqueness presupposition of singular definites.
- Mass nouns are harder. We need a second lattice, and a second part-of relation. Say that $x \sqsubseteq_m y$ means that x is a material part of y: the stuff making up x is included in the stuff making up y.
- $\sqsubseteq_m$ therefore generates a lattice structure, but with no atoms (unless we think there are minimal portions of dog, say).

Masses and ordinary individuals

- We can relate ordinary individuals (atoms or groups) to the stuff they're composed of, using a relation ^{m}: ${}^m a$ is the stuff composing a.
- This is necessary because a new ring can be made of old gold.
- It also has to be iterable, because you can new soup out of old water (composed of even older hydrogen and oxygen).
- There will be various homomorphisms between the different lattices, so if $x \sqsubset_i y$, then ${}^m x \sqsubset_m {}^m y$, etc.

Cumulativity and distributivity

- We can then find algebraic similarities between plurals and mass terms.
- An important one is cumulativity: if x is water and y is water, $x + y$ is water.
- We can also reproduce our earlier exploration of distributivity.
  - If P is a distributive predicate and $P(x) = 1$, x is an atom.
  - If P is a distributive predicate, there is a P^* s.t. if $P^*(x) = 1$, for every atom $x_1, \ldots, x_n$ in x, $P(x_1) \wedge \ldots \wedge P(x_n)$.
  - If P is a collective predicate, $P(x) = 1 \to \exists y, z. y \sqsubset_i x \wedge z \sqsubset_i x \wedge y \neq z$.

Individuals

- Link's theory is complicated. The Bennett/Parsons alternative is complicated. The complexity is in the data.
- We have traded type-theoretic complexity for complexity in the structure of D_e.
- This latter approach makes (natural language) metaphysical claims (Link prefers "ontologicall"): *we talk as if there are far more entities than first glance would suggest*.

  Our guide in ontological matters has to be language itself, it seems to me. So if we have, for instance, two expressions a and b that refer to entities occupying the same place at the same time but have different sets of predicates applying to them, then the entities referred to are simply not the same. From this it follows that my ring and the gold making up my ring are different entities.

Summary

- Distinguish between the fundamental logical ingredients which make compositional semantics possible, and compositional semantic theories which build on those ingredients.
- Central question of natural language metaphysics: What do people talk as if there is?
- A partial answer proposed by Link: people talk as if portions of stuff and individuals stand in a one–many relationship: individuals are not defined only by the stuff they are made of.
- This proposal leads to a natural analysis of various properties of plurals and mass terms.