1 Introductions

2 Go over syllabus

3 Compositionality

Compositionality is a property that a language may have and may lack, namely the property that the meaning of any complex expression is *determined* by the meanings of its parts and the way they are put together. The language can be natural or formal, but it has to be interpreted. That is, meanings, or more generally, *semantic values* of some sort must be assigned to linguistic expressions, and compositionality concerns precisely the distribution of these values. (Pagin & Westerståhl 2010a)

A common way to phrase the requirement:

The meaning of every phrase is a function of the meanings of its parts.

Or as Jacobson puts it (p.2):

[T]here has to be some systematic set of principles that speakers have that allows them to understand their meanings on the basis of the meanings of the smaller parts (ultimately the words) that make them up.

As Jacobson discusses, this principle isn’t just a nice feature for a system of semantic interpretation to have. It’s also motivated by considerations of learnability and usability: kids have to be able to work out what the principles are, and language users have to be able to figure out what to do with novel utterances.

There are lots of challenges to compositionality involving detailed linguistic phenomena: see Pagin & Westerståhl 2010b for discussion of a number of them. It could be that (e.g.) English is non-compositional in light of such problems, but it’s always possible that we just haven’t been clever enough yet to figure out the right analyses of these things. A deeper threat is the charge that compositionality is trivial: any grammar can be made compositional in the sense that the meaning of every phrase is *some* function of the meanings of its parts and the way that they are put together. This is, however, not what’s intended by working semanticists, even if the usual informal definitions leave room for it. The desired principle is something more like the following:
A system of semantic interpretation should assign to every phrase a meaning which is a function of the meanings of its immediate parts, where the function in question is drawn from some manageable list of generally motivated composition principles.

I don’t want to define compositionality this way, only to say that in practice it’s what semanticists seem to have in mind when they say that they are in search of a compositional analysis of some phenomenon. We don’t want a separate rule for computing the meaning of the NP depending on whether NP is dog, goose, or boy with the red balloon. If at all possible, we want one rule that covers them all.

4 Direct compositionality

Formal semanticists would mostly agree with the following rough characterization of our compositional goals (J:4):

the grammar of any natural language is a system of rules (or principles, if one prefers) that define the set of well-formed expressions of the language (i.e., the syntax) and a set of rules (or principles) pairing these with meanings (i.e., the semantics).

Directly compositional grammars — of which Montague’s (1970) pioneering work was an example — is more ambitious (J:4-5):

The hypothesis of Direct Compositionality is a simple one: the two systems work in tandem. Each expression that is proven well-formed in the syntax is assigned a meaning by the semantics - and the syntactic rules or principles which prove an expression as well-formed are paired with the semantics which assign the expression a meaning. (An interesting consequence of this view is that every well-formed syntactic expression does have a meaning.) It is not only the case that every well-formed sentence has a meaning, but also each local expression (“constituent”) within the sentence that the syntax defines as well-formed has a meaning. Of course putting it this way is arguably not much more than just a slogan: the empirical content of this depends in part on just how the syntax works and what one takes to be a meaning.

Theories in which there are syntactic operations which have no immediate semantic effect are thus not directly compositional. We’ll spend a fair bit of time looking at directly vs. non-directly compositional accounts of phenomena such as relative clause interpretation, quantifier scope, and binding.

5 Fragments (J:7)

Inspired by the work of Montague in papers such as Montague 1973, much work in formal semantics within the 1970s and 1980s took it as axiomatic that
a goal was to formulate fully explicit grammars (in both syntactic and semantic
detail) of the fragment of the language one is concerned with (English in most
such work). The term “fragment” got extended to mean not only the portion
of the language being modeled, but also the portion of the grammar being
proposed as an explicit account of the facts. The strategy of writing fragments
(of grammars) has the advantage of giving an explicit theory which makes
testable predictions, and of making theory and/or proposal comparison easier.

Unfortunately, the goal of formulating fully explicit fragments went out of style
during the last two decades or so. This is in part due to the fact that linguistic
theories often promised that many of the particular details did not need to
be stated as they would fall out from very general principles. It is certainly
reasonable to hope that this is ultimately true, but the relevant principles
often go unstated or are stated only rather vaguely - making it extremely
difficult to really compare proposals and/or evaluate theories and theoretical
claims. Having rules and principles be as general as possible is, of course,
highly desirable. But this does not mean that they should not be formulated
explicitly - only that more mileage will be gotten out of explicit formulations.
The present text is therefore committed to trying to revive the notion of explicit
fragment construction. We cannot promise to give every detail of the domain
of English syntax and semantics we are trying to model. Some parts will be left
tentative, some stated informally, and some simply omitted. Nonetheless, the
goal is to give a reasonable amount of an explicit fragment. We will therefore
periodically take stock by summarizing the fragment constructed so far, and a
full summary is provided at the end of Part III.

We’ll pursue this goal, and up the ante a bit by coding up the fragments in Python, along
with explicit (probabilistic) models of the aspects of the world that we need to represent in
order to decide whether the sentences our language assigns meanings to are true or false.

6 Model-theoretic semantics: “No meanings without truth-conditions!”

[T]his book (along with much other modern work in formal semantics) assumes
that meaning is not just some string of symbols, but rather some actual object
out there in the world. Call this a model theoretic object. (More precisely,
we are taking meaning to be an object which forms part of a model which
is an abstract representation of the world: hence the term model theory.)
Of course we need some way to name these objects, and so throughout we
will use strings of symbols as ways to name them. But the point is that the
grammar maps each linguistic expression into something beyond just a symbolic
representation. Otherwise — as so aptly pointed out by David Lewis 1970 —
we are simply mapping one language (say, English) into another (what Lewis
termed “Markerese”). Yet language is used to convey facts about the world; we
draw inferences about the world from what we hear and we gain information about what is true and what is not. So semantics must be a system mapping a linguistic expression to something in the world.

But what exactly is meant by model-theoretic objects? These can in fact be quite abstract. Still, they are the “stuff” that is out there in the universe — something constructed out of actual bits of the universe (or, at least, the ontology of the universe as given by language). This would include things like individuals, times, possibilities and perhaps others; just what are the basic objects that we need is an open question and is part of what semantic theory addresses. The strategy here will be to use a fairly sparse set of primitive objects, and construct more complex objects out of these. Let us, then, begin by setting up two basic building blocks which are foundational in much of the work in linguistic formal semantics. (J:21)

It’s really important to get clear on this. Zoom in on where Jacobson says:

More precisely, we are taking meaning to be an object which forms part of a model which is an abstract representation of the world...

What kinds of representations are these?

- A lot of work in philosophy which assumes that models for semantic theories are representations which bear a privileged relationship to the real world: dog refers (relative to the actual world) to the actual collection of doggy individuals in our world, and not to some concept or representation of dogs.
- Conversely, some people do model-theoretic semantics assuming that the representations in question are really people’s mental models of the world.

I happen to think that the latter interpretation is more useful interpretation for the purposes that motivate me to study semantics. But that’s beside the point: what is crucial is that it does not matter how you interpret the models. Model-theoretic semantics is a mathematical approach to modeling certain aspects of language, and it has the properties that it has by virtue of the formal definitions we use, regardless of how we interpret these properties.

Where it does matter is in considering what kinds of evidence would motivate making adjustments to the theory: e.g., on some extreme interpretations of the externalist position, psychological facts about English speakers are completely irrelevant in formulating a theory of English grammar and interpretation. But we’re treading in some heavy philosophical waters now, so let’s get on to easy topics, like possible worlds!

7 Semantic ontology

The approach we’re taking will require us to assume that there are some basic objects — stuff out of which more complex notions are formed. We’ll assume, for starters,
• The domain of truth-values: \( \{0, 1\} \) (or maybe \( \{0, 1, \text{undefined}\} \))
• The domain of individuals: e.g., \( \{\text{John, Mary, Sue, ...}\} \)
• The domain of times: \( T \), with elements \( \{t, t', ...\} \)
• The domain of possible worlds: \( W \), with elements \( \{w, w', ...\} \)

Other objects in our semantics will be functions from one of these to another, or functions from functions from one of these to another, or ... E.g., we’ll model the denotations of

• **names** as functions from worlds to individuals
• **intransitive verbs** as functions from worlds to (characteristic functions of) sets of individuals
• **transitive verbs** as functions from worlds to (curried) binary relations between individuals
• **ditransitive verbs** as functions from worlds to (curried) ternary relations between individuals

and even more complicated stuff (quickly motivating the adoption of a better way of specifying these functions than using English).

Why possible worlds? Why not have declarative sentences denote truth-values directly, as in (extensional) propositional logic?

• We can know the meaning of a sentence without having any idea whether it is true or false.
• We want to be able to distinguish a situation where \( \phi \) entails \( \psi \) from one in which it just happens that both are true. So, we define: \( \phi \) entails \( \psi \) iff, in every possible world in which \( \phi \) is true, \( \psi \) is true as well.
• We want to be able to distinguish a situation where \( \phi \) and \( \psi \) are **contradictory** from one in which it just happens that one is true and the other false (or both false).
• We have linguistic means to talk about non-actual possibilities, and so presumably need to represent non-actual possibilities in providing them with interpretations:
  
  − It would have been nice if ...
  − The play could have gone better.
  − You should have done something different.
  − You dropping the glass caused it to break. [says more than: you dropped the glass, and it broke]
  − Bill believes that/dreamed that/wondered if he’s a buffalo.
OK, so what do declarative sentences denote? 2 equivalent answers:

- *It’s snowing* denotes the set of possible worlds in which it’s snowing.
- *It’s snowing* denotes the characteristic function of the set just mentioned: the $f$ such that, for all $w \in W$,

$$f(w) = \begin{cases} 1 & \text{if it’s snowing in } w \\ 0 & \text{otherwise} \end{cases}$$

You’ll already have noticed that we frequently use “worlds” when we really mean “world-time pairs”. This is common practice, and hopefully doesn’t lead to any confusion; in cases where we’re explicitly interested in time we’ll make sure not to be careless like this.

8 First steps to a fragment of English

Every expression of a language is modeled as a triple

$$\langle \text{phonological form}, \text{syntactic category}, \text{semantic interpretation} \rangle.$$  

To make life easier, we’ll use orthography instead of phonological form. We’ll start off with a rule for conjunction (J:34)):

**Conjunction rule (temporary):** If $\alpha$ is an expression of the form $\langle [\alpha], S, [\alpha] \rangle$ and $\beta$ is an expression of the form $\langle [\beta], S, [\beta] \rangle$, then there is an expression $\gamma$ of the form $\langle [\alpha-\text{and-}\beta], S, \text{for any } w: [\gamma](w) = 1 \iff [\alpha](w) = [\beta](w) = 1 \rangle$.

Notice that we specified the phonological, syntactic, and semantic effects of this rule at the same time. This is characteristic of the directly compositional style. Notice also that there is lots of English in our definitions. This is fine, as long as we are careful and precise. Later, when it gets too hard to be sufficiently careful in English, we’ll introduce more formalism.

**Disjunction rule (temporary):** If $\alpha$ is an expression of the form $\langle [\alpha], S, [\alpha] \rangle$ and $\beta$ is an expression of the form $\langle [\beta], S, [\beta] \rangle$, then there is an expression $\gamma$ of the form $\langle [\alpha-\text{or-}\beta], S, \text{for any } w: [\gamma](w) = 1 \iff [\alpha](w) = 1 \text{ or } [\beta](w) = 1 \rangle$.

An awkward kind of negation (better version to come soon):

**Negation rule (temporary):** If $\alpha$ is an expression of the form $\langle [\alpha], S, [\alpha] \rangle$, then there is an expression $\beta$ of the form $\langle [\text{it-is-not-the-case-that}-\alpha], S, \text{for any } w: [\beta](w) = 1 \iff [\alpha](w) = 0 \rangle$.

With these three rules, we can now do propositional logic. Suppose we know somehow that our language contains
Then we can use these rules to build up

$$\text{([it’s-raining], S, } \{ \begin{align*} w_1 &\rightarrow 1 \\
w_2 &\rightarrow 1 \\
w_3 &\rightarrow 0 \\
w_4 &\rightarrow 0 \end{align*} \text{)} \quad \text{([it’s-Tuesday], S, } \{ \begin{align*} w_1 &\rightarrow 1 \\
w_2 &\rightarrow 0 \\
w_3 &\rightarrow 1 \\
w_4 &\rightarrow 0 \end{align*} \text{)}$$

where the last two are our first example of a syntactic ambiguity. Note, however, that in this system there is no explicit representation of the syntactic structure: the ambiguity plays out only in
• The potential for different semantic interpretations;
• The fact that we employed the rules of the language in different ways in order to derive these equivalent surface forms.

What are the different steps by which we proved the well-formedness of it’s-not-the-case-that-it’s-raining-or-it’s-Tuesday in each case? Which one is equivalent to a material conditional?

References


