Lecture 1: Introduction to Formal Semantics and Compositionality

1. Compositional Semantics ................................................................. 1
   1.1. The Principle of Compositionality ........................................... 1
   1.2. Model-theoretic Semantics ...................................................... 2
2. Linguistic Examples ................................................................. 3
   2.1. The structure of NPs with restrictive relative clauses .............. 3
   2.2. Phrasal and sentential conjunction ........................................ 4
REFERENCES ................................................................. 4
“HOMEWORK” No. 0: Participant Questionnaire ................................ 5

Bring next time: Participant Questionnaire: see last page.

1. Compositional Semantics

1.1. The Principle of Compositionality.

A basic starting point of generative grammar: there are infinitely many sentences in any natural language, and the brain is finite, so linguistic competence must involve some finitely describable means for specifying an infinite class of sentences. That is a central task of syntax.

Semantics: A speaker of a language knows the meanings of those infinitely many sentences, is able to understand a sentence he/she has never heard before or to express a meaning he/she has never expressed before. So for semantics also there must be a finite way to specify the meanings of the infinite set of sentences of any natural language.

A central principle of formal semantics is that the relation between syntax and semantics is compositional.

The Principle of Compositionality: The meaning of an expression is a function of the meanings of its parts and of the way they are syntactically combined.

Each of the key terms in the principle of compositionality is a “theory-dependent” term, and there are as many different versions of the principle as there are ways of specifying those terms. (meaning, function, parts (syntax))

Some of the different kinds of things meanings could be in a compositional framework:

(a) (early Katz and Fodor) Representations in terms of semantic features. bachelor: [+HUMAN, +MALE, +ADULT, +NEVER-MARRIED (?!)]. Semantic composition: adding feature sets together. Problems: insufficient structure for the representations of transitive verbs, quantifiers, and many other expressions; unclear status of uninterpreted features.

(b) Representations in a “language of thought” or “conceptual representation” (Jackendoff, Jerry Fodor); if semantics is treated in terms of representations, then semantic composition becomes a matter of compositional translation from a syntactic representation to a semantic representation.

(c) The logic tradition: Frege, Tarski, Carnap, Montague. The basic meaning of a sentence is its truth-conditions: to know the meaning of a sentence is to know what the world must be like if the sentence is true. Knowing the meaning of a sentence does not require knowing
whether the sentence is *in fact* true; it only requires being able to discriminate between situations in which the sentence is true and situations in which the sentence is false.

Starting from the idea that the meaning of a sentence consists of its truth-conditions, meanings of other kinds of expressions are analyzed in terms of their contribution to the truth-conditions of the sentences in which they occur.

### 1.2. Model-theoretic Semantics.

In formal semantics, truth-conditions are expressed in terms of truth relative to various parameters — a formula may be true at a given time, in a given possible world, relative to a certain context that fixes speaker, addressee, etc., and relative to a certain assignment of meanings to its atomic “lexical” expressions and of particular values to its variables. For simple formal languages, all of the relevant variation except for assignment of values to variables is incorporated in the notion of truth relative to a *model*. Semantics which is based on truth-conditions is called *model-theoretic*.

### Compositionality in the Montague Grammar tradition:

The task of a *semantics* for language L is to provide truth conditions for every well-formed sentence of L, and to do so in a compositional way. This task requires providing appropriate model-theoretic interpretations for the *parts* of the sentence, including the lexical items.

The task of a *syntax* for language L is (a) to specify the set of well-formed expressions of L (of every category, not only sentences), and (b) to do so in a way which supports a compositional semantics. The syntactic part-whole structure must provide a basis for semantic rules that specify the meaning of a whole as a function of the meanings of its parts.

### Basic structure in classic Montague grammar:

1. **Syntactic categories and semantic “types”**: For each syntactic category there must be a uniform semantic type. For example, one could hypothesize that sentences express propositions, nouns and adjectives express properties of entities, verbs express properties of events.

2. **Basic (lexical) expressions and their interpretation.** Some syntactic categories include basic expressions; for each such expression, the semantics must assign an interpretation of the appropriate type. Within the tradition of formal semantics, most lexical meanings are left unanalyzed and treated as if primitive; Montague regarded most aspects of the analysis of lexical meaning as an empirical rather than formal matter; formal semantics is concerned with the types of lexical meanings and with certain aspects of lexical meaning that interact directly with compositional semantics, such as verbal aspect.

3. **Syntactic and semantic rules.** Syntactic and semantic rules come in pairs:

   `<Syntactic Rule n, Semantic Rule n>`: in this sense compositional semantics concerns “the semantics of syntax”.

   **Syntactic Rule n**: If \( \alpha \) is an expression of category A and \( \beta \) is an expression of category B, then \( F_i(\alpha, \beta) \) is an expression of category C. [where \( F_i \) is some syntactic operation on expressions]

   **Semantic Rule n**: If \( \alpha \) is interpreted as \( \alpha' \) and \( \beta \) is interpreted as \( \beta' \), then \( F_i(\alpha, \beta) \) is interpreted as \( G_k(\alpha', \beta') \). [where \( G_k \) is some semantic operation on semantic interpretations]

Illustration: See syntax and semantics of predicate calculus in Section 3.
2. Informal Linguistic Examples.
(See also the Larson chapter)
These are examples of some of the kinds of problems that we will be able to solve after we have developed some of the tools of formal semantics. Some of these, and other, linguistic problems will be discussed in future lectures.

2.1. The structure of NPs with restrictive relative clauses.
Consider NPs such as “the boy who loves Mary”, “every student who dances”, “the doctor who treated Mary”, “no computer which uses Windows”. Each of these NPs has 3 parts: a determiner (DET), a common noun (CN), and a relative clause (RC). The question is: Are there semantic reasons for choosing among three different possible syntactic structures for these NPs?

a. Flat structure:

```
  NP
 /   \
|   |
DET   CN   RC
  |   |
the   boy  who loves Mary
```

b. “NP - RC” structure: The relative clause combines with a complete NP to form a new NP.

```
  NP
 /   \  
NP   RC  
 /   \  
DET   CN  
  |   |
the   boy  who loves Mary
```

c. “CNP - RC” structure: (CNP: common noun phrase: common noun plus modifiers)

```
  NP
 /   \
|   |
DET   CNP
 /   \
|   |
CNP   RC
 /   \
|   |
CN
  |   |
the   boy  who loves Mary
```

Argument: we can argue that compositionality requires the third structure: that “boy who loves Mary” forms a semantic constituent with which the meaning of the DET combines. We can show that the first structure does not allow for recursivity, and that the second structure
cannot be interpreted compositionally. (The second structure is a good structure to provide a basis for a compositional interpretation for non-restrictive relative clauses.)

2.2. Phrasal and sentential conjunction.

Consider the following equivalent and non-equivalent pairs, where the first sentence has phrasal conjunction (VP-conjunction, in particular) and the second has sentential conjunction (S-conjunction). The puzzle is to explain why some examples are semantically equivalent and some are not, although in each case the surface syntactic relation is the same.

\[ \text{John sings and dances} = \text{John sings and John dances} \]
\[ \text{One boy sings and dances} \neq \text{One boy sings and one boy dances} \]
\[ \text{Every boy sings and dances} = \text{Every boy sings and every boy dances} \]
\[ \text{No boy sings and dances} \neq \text{No boy sings and no boy dances} \]

We will need two parts to solve this puzzle: (i) the syntax and semantics of sentential and phrasal conjunction, particularly the question of how they are related; and (ii) the semantics of the Determiners *one, every, no* (and others), as well as of simple NPs like *John*. This topic isn’t so far on the agenda for this year. One place you can read about it is in Partee and Rooth (1983).

REFERENCES.

(Some of these will be referred to in later lectures.)


“HOMEWORK” No. 0: Participant Questionnaire
Please answer the following questions for me. Short answers: no more than 2 pages total.
Questionnaire due at the time of Lecture 2.

1. Your name
2. Your “status” — 2nd, 3rd, ..., year student in the linguistics program, philosophy program, or other.
3. (Briefly) How much / what kind of the following have you studied?
   a. Semantics
   b. Syntax
   c. Logic
   d. Mathematics
4. What other languages do you have some knowledge of? What languages have you done some linguistic work on, or are planning to in the future?
5. Write two or three sentences about what areas of linguistics or philosophy (or …) you are most interested in and what you might like to do for a future career.
6. Write one or two sentences about why you are taking this course and what you hope to learn from it.