Chapter 5

Semantics

5.1 Lecture notes

Chapter 5, Lecture One

I. **Semantics: What and Why**

? Why do we need to deal with semantics in a syntax course?

- Because syntax and semantics are intertwined:
  1. distribution of reflexives
  2. semantic correlates to valence
  3. semantic correlates to other syntactic features, such as NUM and COUNT
- The basic goal of our semantic analysis is to associate sentences with an (admittedly primitive) account of who did what to whom, when, where, etc.

? What is the basic 'who did what to whom' for *Bo visited Lee yesterday*?

- We can think of this S as describing a situation s where: **[Slides:1–2]**
  - s is a visiting situation
  - the visitor is i
  - i is named Bo

- the person being visited is j
- j is named Lee
- s happened yesterday

- The sentence *Did Bo visit Lee yesterday?* is asking whether there was a situation like this.
- This is the kind of information that we use SEM values to express.

II. Semantics in our grammar: Features

- Our feature structures will now have 2 top-level features: SYN and SEM. Each of them has a feature structure as values.

? What are the features (so far) that appear in each of them? **[Slides:3]**

SYN: HEAD, COMPS, and SPR
SEM: MODE, INDEX, and RESTR

- This is all we'll have in SEM. We will be adding more syntactic features.

? What are the possible values of MODE? [prop, ques, dir, & ref].

? What do they represent?

- prop: assertion of something that can be true or false
- ques: a request for information
- dir: an instruction to do something
- ref: a reference to something in the world

? Why are these the values? (These seem like a good first stab at a gross classification of the things we use utterances for.)

? Can you think of any other uses of utterances that can't be viewed as special cases of these?

? What are the possible values of INDEX? (Any integer, but we use lower-case letters for this.)

? What do they represent? (They are intended as pointers to the entity (in the case of [MODE ref]) or situation (in the case of any other MODE value) that the expression denotes.)

- What about the RESTR values? This is where most of the action in the SEM feature is. The value of RESTR is a list of feature structures, each of which represents a constraint on the situation or entity denoted.
- SIT and INDEX values within the feature structures in a RESTR list allow us to express how these constraints are related to one another.
- Here we are following the same overall strategy as in our syntactic analyses, breaking down complex relationships within an expression into lots of simple constraints that must be simultaneously satisfied.

III. **Flat semantics**

- Example: The semantics of *My mother relies on you* might be something like: **[Slides:4]**

? What would the effect be of changing the order of the elements in a RESTR list? (None; though we have represented these as lists, they could just as well be sets.)

- The syntactic representations are quite hierarchical, but the semantic representations are almost totally flat. One manifestation of this is that there is no grouping in the SEM value of a clause (an S node) that corresponds to the syntactic VP. (In the example here, the relations coming from *relies on you* do not form any special sub-group in the RESTR of the S.)
- Many formalisms for semantic representation that are found in the literature are based on first-order predicate logic. This system can be augmented in various ways, one of which is equivalent to a standard predicate logic with generalized quantifiers (and events). For a detailed account of this sort of 'Minimal Recursion Semantics' (MRS), see Copestake et al. 1999.

IV. **Notes on MRS for an advanced course**

- There are two primary differences between this kind of semantics and standard formulations of, e.g. predicate logic with generalized quantifiers:

1. The MRS-style is 'flat'. A logic formula is represented as a list (or 'bag') of predications. Instead of embedding one structure within another (the standard presentation), embedding is simulated by identifying the predication's 'handle' (a label that goes with each predication) or its event variable with the argument of some other predication. A fully 'connected' representation is formally equivalent to a standard one with embedding.
2. The MRS-style, because it simulates embedding via identification, need not specify all the identities in a given representation. Therefore the MRS-style representation, unlike the standard one, allows partial scope representations. That is, a sentence like *Someone loves everyone* can be given a single representation that is underspecified with respect to quantifier scope.

- Being able to underspecify quantifier scope is realistic, both psycholinguistically and computationally. There is no reason to believe that when people process sentences with multiple quantifiers, they resolve the scopes fully. Moreover, if computational systems had to fully resolve scope they would not be likely to function at all efficiently, as the problem of resolving scopes fully (which corresponds on the standard view to choosing one from among a set of distinct representations permitted by the grammar for a given sentence) is too hard. It is, as people often say, an 'AI-complete' problem. Another advantage of the flat MRS-style representation is that it allows easy bookkeeping: when we try to model sentence generation, for example, it is essential at any given stage of process to keep track of which input information has already been expressed and which remains to be expressed. By representing meanings as flat lists, MRS allows this to be done efficiently.

Chapter 5, Lecture Two

I. Compositionality

- A central issue in much work on semantics has been compositionality: How are the meanings of complex expressions built up from the meanings of simpler expressions? This question, first raised

by Frege, has to be answered, since language is productive. We will say as much about it as we have to in order to have a satisfactory syntactic theory, i.e. one that can be shown to support the association of sentences with appropriate meanings.

- In our grammar, the Semantic Compositionality Principle and the Semantic Inheritance Principle are responsible for making sure that the meanings of each part of a sentence contribute to the meaning of the whole sentence in an appropriate way.
- For example, consider how the index of a noun gets to be the value of an argument role in a verb's lexical entry.
  1. The verb's lexical entry, e.g. *visited*, says that the index of the subject NP is identical to the visitor in the visiting predication. **[Slides:5]**
  2. This SPR $\langle$ NP$_i$ $\rangle$ specification is passed up to the VP the verb is the head of. Why? (The Valence Principle.)
  3. But here the SPR value of the VP will be unified with the whole category of the subject NP. Why? (The Head-Specifier Rule.)
  4. So all this guarantees that the subject NP has the same index as the visitor.
  5. But the information that this individual is named Bo is given in the lexical entry for the noun Bo (the INDEX value is identified with the NAMED value in the name predication.) **[Slides:6]**
  6. So something has to pass this up to be the index of the NP, so that when the subject and VP combine, the person named Bo gets identified with the visitor.
  7. The meaning of the S isn't complete without that identification happening. That's why the SIP identifies INDEX. **[Slides:7]**
- What about MODE? Well, the verb did in *Did Bo visit Kim yesterday* will specify lexically the MODE value question. And this has to get up to the top to be the MODE value of the whole sentence. In *Bo visited Kim yesterday*, the verb's MODE value is prop and this has to get to the top to be the MODE value of

the whole sentence. In general – the MODE value of a phrase comes from its head daughter (and the MODE value of that head daughter comes from its head daughter....). That's the work done by the MODE identification of the SIP. **[Slides:8–9]**

II. Modifiers

- Modifiers. The lexical entry for *yesterday* looks at the INDEX (a situational index) of its MOD value and identifies this with the ARG value in the yesterday predication. **[Slides:10]**
- This ensures that once the MOD value of the AdvP is identified with the whole category of the phrase modified the result will be that the visiting situation is the argument of the relation (or predicate) yesterday. **[Slides:11]**

? How does the MOD value get to the AdvP? (The HFP.)

? What identifies the MOD value of the AdvP with the modified phrase? (The Head-Modifier Rule.)

- Our semantics can also model semantic unacceptability.

? What is wrong with this sentence: *Kim visited Lee tomorrow.*

- Answer, the past tense verb form has some predications in its RESTR value which locate the described situation with respect to the time of utterance. **[Slides:12]**
- The meaning of *tomorrow*, on the other hand, requires of its ARG that it be a situation located in a day that follows the day of the time of utterance. **[Slides:13]**
- Hence, though the example is well-formed grammatically, it involves a bunch of conditions on the described situations that can never be satisfied. This is a semantic contradiction. **[Slides:14]**

III Coordination

- How does the semantics of coordination work? Consider:

  (1) Bo visited Lee and saw Kim.

- This describes a compound situation (the one that is the SIT argument of the and predication) that has component situations (the situations in the list that is the ARGS value of the *and* predication. **[Slides:15]**

? What can we say about the visitor and the seer? (They have to be the same — the individual named Bo.)

? Does our analysis get this right? (Yes. each VP conjunct has a [SPR $\langle$ NP$_i$ $\rangle$] included in its SYN. The Coordination rule makes these be identical. And each V has the same SPR specification (Why? - Ans: the Valence Principle), but each verb links the index of its SPR value to a particular participant in its semantic predication. Hence these constraints all interact to ensure that the visitor is the same individual as the seer. And that's absolutely necessary to get the sentence to have the right meaning.) **[Slides:16–17]**

- Consider the sentence: **[Slides:18]**

  (2) Bo visited Lee and saw Kim yesterday.

? This sentence is structurally ambiguous. What are the two structures? **[Slides:19–20]**

- In our discussion of CFG, we argued that the fact that CFG can differentiate these structures means that it can account for the ambiguity. In fact, we haven't captured the ambiguity until we show how we can pair the different structures with different semantic representations.

? What is the MOD value of *yesterday* in each structure? (The coordinated VP *visited Lee and saw Kim* in one and just the simple VP *saw Kim* in the other.)

? What is the ARG of yesterday in each structure? (The compound situation in one (u) and the SIT value of just *saw Kim* (t) in the other.) **[Slides:21–22]**

- If it's not assigned as homework, go through Problem 5.1 in class.