Ling 566
Oct 14, 2010
Semantics
Overview

- Leftovers: Count v. Mass
- Some notes on the linguist’s stance
- Which aspects of semantics we’ll tackle
- Our formalization; Semantics Principles
- Building semantics of phrases
- Modification, coordination
- Structural ambiguity
The Count/Mass Distinction

- Partially semantically motivated
  - mass terms tend to refer to undifferentiated substances (*air, butter, courtesy, information*)
  - count nouns tend to refer to individuatable entities (*bird, cookie, insult, fact*)
- But there are exceptions:
  - *succotash* (mass) denotes a mix of corn & lima beans, so it’s not undifferentiated.
  - *furniture, footwear, cutlery*, etc. refer to individuatable artifacts with mass terms
  - *cabbage* can be either count or mass, but many speakers get *lettuce* only as mass.
  - borderline case: *data*
Our Formalization of the Count/Mass Distinction

- Determiners are:
  - [COUNT −] (*much* and, in some dialects, *less*),
  - [COUNT +] (*a*, *six*, *many*, etc.), or
  - lexically underspecified (*the*, *all*, *some*, *no*, etc.)
- Nouns select appropriate determiners
  - “count nouns” say SPR <[COUNT +]>
  - “mass nouns” say SPR <[COUNT −]>
- Nouns themselves aren’t marked for the feature COUNT
- So the SHAC plays no role in count/mass marking.
The Linguist's Stance: Building a precise model

• Some of our statements are statements about how the model works:

  “[prep] and [AGR 3sing] can’t be combined because AGR is not a feature of the type prep.”

• Some of our statements are statements about how (we think) English or language in general works.

  “The determiners a and many only occur with count nouns, the determiner much only occurs with mass nouns, and the determiner the occurs with either.”

• Some are statements about how we code a particular linguistic fact within the model.

  “All count nouns are [SPR < [COUNT +]>].”
The Linguist's Stance:
A Vista on the Set of Possible English Sentences

• ... as a background against which linguistic elements (words, phrases) have a distribution

• ... as an arena in which linguistic elements “behave” in certain ways
So far, our grammar has no semantic representations. We have, however, been relying on semantic intuitions in our argumentation, and discussing semantic contrasts where they line up (or don't) with syntactic ones.

Examples?

- structural ambiguity
- S/NP parallelism
- count/mass distinction
- complements vs. modifiers
Our Slice of a World of Meanings

Aspects of meaning we won’t account for

- Pragmatics
- Fine-grained lexical semantics:

The meaning of *life* is *life*’, or, in our case,

```
[ RELN    life ]
[ INST    i  ]
```
“... the linguistic meaning of *Chris saved Pat* is a proposition that will be true just in case there is an actual situation that involves the saving of someone named Pat by someone named Chris.” (p. 140)
Our Slice of a World of Meanings

What we are accounting for is the compositionality of sentence meaning.

• How the pieces fit together

  Semantic arguments and indices

• How the meanings of the parts add up to the meaning of the whole.

  Appending RESTR lists up the tree
Semantics in Constraint-Based Grammar

• Constraints as (generalized) truth conditions
  • proposition: what must be the case for a proposition to be true
  • directive: what must happen for a directive to be fulfilled
  • question: the kind of situation the asker is asking about
  • reference: the kind of entity the speaker is referring to

• Syntax/semantics interface: Constraints on how syntactic arguments are related to semantic ones, and on how semantic information is compiled from different parts of the sentence.
Feature Geometry

\[
\begin{align*}
\text{SYN} & : \begin{bmatrix}
\text{HEAD} & pos \\
\text{VAL} & \begin{bmatrix} \text{SPR} & \text{list}(expression) \\ \text{COMPS} & \text{list}(expression) \end{bmatrix} \\
\text{SEM} & : \begin{bmatrix}
\text{MODE} & \{ \text{prop}, \text{ques}, \text{dir}, \text{ref}, \text{none} \} \\
\text{INDEX} & \{ i, j, k, \ldots s_1, s_2, \ldots \} \\
\text{RESTR} & \text{list}(pred) \\
\end{bmatrix}
\end{align*}
\]
How the Pieces Fit Together

\[
\left< \text{Dana} , \right>
\]

\[
\begin{array}{c}
\text{word} \\
\text{SYN} \\
\text{VAL} \\
\text{SEM} \\
\end{array}
\]

\[
\begin{array}{c}
\text{HEAD} \\
\text{AGR} \\
\text{noun} \\
\text{3sing} \\
\text{SPR} \\
\text{COMPS} \\
\text{SPR} \langle \rangle \\
\text{COMPS} \langle \rangle \\
\text{INDEX} \\
\text{MODE} \\
\text{ref} \\
\text{INDEX} \\
\text{MODE} \\
\text{ref} \\
\text{RESTR} \\
\text{NAME} \\
\text{Dana} \\
\text{NAMED} \\
\end{array}
\]
How the Pieces Fit Together

\[
\langle \text{slept,} \rangle
\]

\[
\text{word}
\]

\[
\text{SYN}
\]

\[
\text{SEM}
\]

\[
\text{HEAD} \quad \text{verb}
\]

\[
\text{VAL}
\]

\[
\text{SPR} \quad \langle \text{NP} \rangle
\]

\[
\text{COMPS} \quad \langle \rangle
\]

\[
\text{INDEX} \quad s_1
\]

\[
\text{MODE} \quad \text{prop}
\]

\[
\text{RESTR}
\]

\[
\text{RELN} \quad \text{sleep}
\]

\[
\text{SIT} \quad s_1
\]

\[
\text{SLEEPER} \quad j
\]

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The Pieces Together

Dana slept
A More Detailed View of the Same Tree

[Diagram of a tree structure with nodes labeled as follows: S, INDEX, MODE, RESTR, 1NP, VP, SEM, RELN name, NAME Dana, NAMED i, SPR, VAL, SLEEPER i, sleep, SIT, s₁, and i. The tree structure is not fully transcribed here.]
To Fill in Semantics for the S-node

We need the Semantics Principles

- The Semantic Inheritance Principle:

  In any headed phrase, the mother's MODE and INDEX are identical to those of the head daughter.

- The Semantic Compositionality Principle:
Semantic Inheritance Illustrated
To Fill in Semantics for the S-node

We need the Semantics Principles

• The Semantic Inheritance Principle:
  
  In any headed phrase, the mother's MODE and INDEX are identical to those of the head daughter.

• The Semantic Compositionality Principle:
  
  In any well-formed phrase structure, the mother's RESTR value is the sum of the RESTR values of the daughter.
Semantic Compositionality Illustrated

\[ S \]

\[
\begin{array}{c}
\text{SEM} \\
\text{INDEX } s_1 \\
\text{MODE } \text{prop} \\
\text{RESTR} \left\langle \begin{array}{c}
\text{RELN } \text{name} \\
\text{NAME } \text{Dana} \\
\text{NAMED } i
\end{array} \right\rangle, \begin{array}{c}
\text{RELN } \text{sleep} \\
\text{SIT } s_1 \\
\text{SLEEPER } i
\end{array}, \ldots
\end{array}\]

\[ \text{NP} \]

\[
\begin{array}{c}
\text{SEM} \\
\text{INDEX } i \\
\text{RESTR} \left\langle \begin{array}{c}
\text{RELN } \text{name} \\
\text{NAME } \text{Dana} \\
\text{NAMED } i
\end{array} \right\rangle
\end{array}\]

\[ \text{VP} \]

\[
\begin{array}{c}
\text{SEM} \\
\text{RESTR} \left\langle \begin{array}{c}
\text{RELN } \text{sleep} \\
\text{SIT } s_1 \\
\text{SLEEPER } i
\end{array} \right\rangle, \ldots
\end{array}\]

\[ \text{SYN} \left[ \text{VAL} \left[ \text{SPR} \left\langle 1 \right\rangle \right] \right] \]
What Identifies Indices?

S

NP

D NOM

the cat

VP

SPR ⟨1⟩

RESTR

RELN SIT sleep s₃

SLEEPERᵢ

slept

PP

on the mat
Summary: Words ...

• contribute predcations
• ‘expose’ one index in those predcations, for use by words or phrases
• relate syntactic arguments to semantic arguments
Summary: Grammar Rules ...

- identify feature structures (including the INDEX value) across daughters

HeadSpecifierRule

\[
\begin{align*}
\text{phrase} & \quad \text{SYN} \left[ \text{VAL} \left[ \text{SPR} \langle \rangle \right] \right] \\
& \quad \rightarrow \quad \text{H} \left[ \text{SYN} \left[ \text{VAL} \left[ \text{SPR} \langle \rangle \right] \right] \right]
\end{align*}
\]

HeadComplementRule

\[
\begin{align*}
\text{phrase} & \quad \text{SYN} \left[ \text{VAL} \left[ \text{COMPS} \langle \rangle \right] \right] \\
& \quad \rightarrow \quad \text{H} \left[ \text{word} \right] \quad \text{SYN} \left[ \text{VAL} \left[ \text{COMPS} \langle \rangle \right] \right]
\end{align*}
\]

HeadModifierRule

\[
\begin{align*}
\text{phrase} & \quad \rightarrow \quad \text{H} \left[ \text{SYN} \left[ \text{COMPS} \langle \rangle \right] \right] \quad \text{SYN} \left[ \text{VAL} \left[ \text{COMPS} \langle \rangle \right] \right]
\end{align*}
\]
Summary: Grammar Rules ...

- identify feature structures (including the INDEX value) across daughters
- license trees which are subject to the semantic principles
  - SIP ‘passes up’ MODE and INDEX from head daughter

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Summary: Grammar Rules ...

- identify feature structures (including the INDEX value) across daughters
- license trees which are subject to the semantic principles
  - SIP ‘passes up’ MODE and INDEX from head daughter
  - SCP: ‘gathers up’ predications (RESTR list) from all daughters
Other Aspects of Semantics

- Tense, Quantification (only touched on here)
- Modification
- Coordination
- Structural Ambiguity
Evolution of a Phrase Structure Rule

Ch. 2:  \[ \text{NOM} \rightarrow \text{NOM PP} \]
       \[ \text{VP} \rightarrow \text{VP PP} \]

Ch. 3:  \[ \begin{bmatrix}
\text{phrase} \\
\text{VAL}
\end{bmatrix}
\rightarrow
\begin{bmatrix}
\text{H} \\
\text{VAL}
\end{bmatrix}
\begin{bmatrix}
\text{COMPS} \\
\text{SPR}
\end{bmatrix}
\]

Ch. 4:  \[ \begin{bmatrix}
\text{phrase}
\end{bmatrix}
\rightarrow
\begin{bmatrix}
\text{H} \\
\text{VAL}
\end{bmatrix}
\begin{bmatrix}
\text{COMPS}
\end{bmatrix}
\]

Ch. 5:  \[ \begin{bmatrix}
\text{phrase}
\end{bmatrix}
\rightarrow
\begin{bmatrix}
\text{H} \left[ \text{SYN} \left[ \text{VAL} \left[ \text{COMPS} \right] \right] \right] \\
\text{SYN} \\
\text{VAL} \\
\text{COMPS}
\end{bmatrix}
\left[ \text{MOD} \left[ \text{COMPS} \right] \right] \]

Ch. 5 (abbreviated):  \[ \begin{bmatrix}
\text{phrase}
\end{bmatrix}
\rightarrow
\begin{bmatrix}
\text{H} \left[ \text{COMPS} \right] \\
\text{COMPS}
\end{bmatrix}
\left[ \text{MOD} \left[ \text{COMPS} \right] \right] \]
Evolution of Another Phrase Structure Rule

Ch. 2: \[ X \rightarrow X^+ \text{ CONJ } X \]

Ch. 3: \[ 1 \rightarrow 1^+ \left[ \begin{array}{c} \text{word} \\ \text{HEAD} \\ \text{conj} \end{array} \right] 1 \]

Ch. 4: \[ \begin{array}{c} \text{VAL} \\ \text{HEAD} \\ \text{conj} \end{array} [1] \rightarrow [VAL [1]^+] \left[ \begin{array}{c} \text{word} \\ \text{HEAD} \\ \text{conj} \end{array} [VAL [1]] \right] \]

Ch. 5: \[ \begin{array}{c} \text{SYN} \\ \text{SEM} \end{array} [\text{VAL} [0]] \rightarrow \]
\[ \begin{array}{c} \text{SYN} \\ \text{SEM} \end{array} [\text{VAL} [0]] \cdots [\text{SYN} \\ \text{SEM} \end{array} [\text{IND} \; s_1] \cdots [\text{SYN} \\ \text{SEM} \end{array} [\text{IND} \; s_{n-1}] \]
\[ \left[ \begin{array}{c} \text{SYN} \\ \text{SEM} \end{array} [\text{HEAD} \; \text{conj}] \\ \text{IND} \; s_0 \\ \text{RESTR} \langle [\text{ARGS} \langle s_1 \ldots s_n \rangle] \rangle \end{array} \right] \left[ \begin{array}{c} \text{SYN} \\ \text{SEM} \end{array} [\text{VAL} [0]] \right] \]

Ch. 5 (abbreviated):
\[ \begin{array}{c} \text{VAL} [0] \\ \text{IND} \; s_0 \end{array} \rightarrow \begin{array}{c} \text{VAL} [0] \\ \text{IND} \; s_1 \end{array} \cdots \begin{array}{c} \text{VAL} [0] \\ \text{IND} \; s_{n-1} \end{array} \left[ \begin{array}{c} \text{HEAD} \; \text{conj} \\ \text{IND} \; s_0 \\ \text{RESTR} \langle [\text{ARGS} \langle s_1 \ldots s_n \rangle] \rangle \end{array} \right] \left[ \begin{array}{c} \text{VAL} [0] \\ \text{IND} \; s_n \end{array} \right] \]
Combining Constraints and Coordination

Coordination Rule

\[
\begin{array}{c}
\begin{bmatrix}
\text{VAL} & 0 \\
\text{IND} & s_0
\end{bmatrix} \\
\rightarrow
\begin{bmatrix}
\text{VAL} & 0 \\
\text{IND} & s_1
\end{bmatrix} \ldots \\
\begin{bmatrix}
\text{VAL} & 0 \\
\text{IND} & s_{n-1}
\end{bmatrix}
\end{array}
\begin{array}{c}
\begin{bmatrix}
\text{HEAD} & \text{conj} \\
\text{IND} & s_0
\end{bmatrix}
\end{array}
\begin{array}{c}
\begin{bmatrix}
\text{RESTR} & \langle \text{ARGS} \langle s_1 \ldots s_n \rangle \rangle
\end{bmatrix}
\end{array}
\begin{array}{c}
\begin{bmatrix}
\text{VAL} & 0 \\
\text{IND} & s_n
\end{bmatrix}
\end{array}
\end{array}
\]

Lexical Entry for a Conjunction

\[
\begin{array}{c}
\langle \text{and} , \rangle
\end{array}
\begin{array}{c}
\begin{bmatrix}
\text{SYN} & \\
\text{SEM}
\end{bmatrix}
\begin{bmatrix}
\text{HEAD} & \text{conj} \\
\text{INDEX} & s \\
\text{MODE} & \text{none}
\end{bmatrix}
\begin{bmatrix}
\text{RESTR} & \langle \text{RELN} \langle \text{and} \rangle \rangle \\
\text{SIT} & s
\end{bmatrix}
\end{array}
\]

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Combining Constraints and Coordination

Lexical Entry for and

\[
\langle \text{and} \rangle,
\begin{array}{c|c|c|c}
\text{SYN} & \text{HEAD} & \text{INDEX} & \text{MODE} \\
\hline
& \text{conj} & s & \text{none} \\
\text{SEM} & \text{RESTR} & \langle \text{RELN and SIT} s \rangle & \\
\end{array}
\]

Coordination Rule

\[
\begin{align*}
\begin{bmatrix} \text{VAL} \begin{bmatrix} 0 \end{bmatrix} \\ \text{IND} \begin{bmatrix} s_0 \end{bmatrix} \end{bmatrix} & \rightarrow \begin{bmatrix} \text{VAL} \begin{bmatrix} 0 \end{bmatrix} \\ \text{IND} \begin{bmatrix} s_1 \end{bmatrix} \end{bmatrix} \cdots \begin{bmatrix} \text{VAL} \begin{bmatrix} 0 \end{bmatrix} \\ \text{IND} \begin{bmatrix} s_{n-1} \end{bmatrix} \end{bmatrix} \\
\text{RESTR} & \langle \text{ARGS} \begin{bmatrix} s_1 \ldots s_n \end{bmatrix} \rangle
\end{align*}
\]

\[
\begin{bmatrix} \text{HEAD} \begin{bmatrix} \text{conj} \end{bmatrix} \\ \text{IND} \begin{bmatrix} s_0 \end{bmatrix} \end{bmatrix} \rangle
\]

\[
\begin{bmatrix} \text{VAL} \begin{bmatrix} 0 \end{bmatrix} \\ \text{IND} \begin{bmatrix} s_n \end{bmatrix} \end{bmatrix}
\]
Structural Ambiguity, Tree I

S
[IND s₀]

S
[IND s₀]

S
[IND s₁]

NP
Pat

IND
s₀

MODE
prop

RELN
name

NAME
Pat

NAMED
k

RELN
name

NAME
Lee

NAMED
j

RELN
sing

SIT
s₁

SINGER
k

RELN
dance

SIT
s₂

DANCER
j

RELN
and

SIT
s₀

ARGS
⟨s₁, s₂⟩

RELN
frequently

ARG
s₀

ADV
[MOD ⟨⟩]

frequently

|
Structural Ambiguity, Tree II

S
[IND s₀]

S
CONJ

S
[IND s₁]

NP
VP

NP
VP

Pat
sings

and

Lee
dances

[IND s₂]

[IND s₂]

[IND s₂]

[MOD ⟨□⟩]

frequently

[RELN name NAME Pat NAMED k]

[RELN sing SIT s₁]

[SIT s₀]

[ARGS ⟨s₁, s₂⟩]

[RELN and SIT]

[RELN dance SIT]

[RELN frequently]

[ARG s₂]

[MODE prop]

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Question About Structural Ambiguity

Why isn’t this a possible semantic representation for the string *Pat sings and Lee dances frequently*?
Semantic Compositionality

\[
\begin{align*}
\text{IND } s_0 &\quad \text{MODE prop} \\
\text{RESTR} &\quad \langle \text{RELN name NAME Pat NAMED k}, \text{RELN sing SIT } s_1, \text{RELN and SIT } s_0, \text{ARGS } \langle s_1, s_2 \rangle, \text{RELN frequently ARG } s_0, \text{RELN dance SIT } s_2, \text{DANCER } j \rangle \\
\text{IND } s_0 &\quad \text{MODE prop} \\
\text{RESTR} &\quad \langle \text{RELN name NAME Pat NAMED k}, \text{RELN sing SIT } s_1, \text{RELN and SIT } s_0, \text{ARGS } \langle s_1, s_2 \rangle, \text{RELN frequently ARG } s_0, \text{RELN dance SIT } s_2, \text{DANCER } j \rangle
\end{align*}
\]
Overview

• Some notes on the linguist’s stance
• Which aspects of semantics we’ll tackle
• Our formalization; Semantics Principles
• Building semantics of phrases
• Modification, coordination
• Structural ambiguity
• Next time: How the grammar works