Ling 566
Nov 15, 2007
Auxiliaries
Overview

• What are auxiliaries?
• General properties of auxiliaries
• Lexical type/lexical entries for auxiliaries
• NICE properties (lexical rules)
What Auxiliaries Are

- Sometimes called “helping verbs,” auxiliaries are little words that come before the main verb of a sentence, including forms of be, have, do, can, could, may, might, must, shall, should, will, and would.

- They tend to be involved in the expression of time, necessity, possibility, permission, and obligation, as well as such things as negation, affirmation, and questioning.
• They are optional
  \textit{Pat tapdanced. Pat can tapdance. Pat is tapdancing.}

• They precede any non-auxiliary verbs
  \textit{*Pat tapdance can. *Pat tapdancing is.}

• They determine the form of the following verb
  \textit{*Pat can tapdancing. *Pat is tapdance.}

• When they co-occur, their order is fixed
  \textit{Pat must be tapdancing. *Pat is musting tapdance.}

• Auxiliaries of any given type cannot iterate
  \textit{*Pat could should tapdance.
A Little History

• Chomsky’s first book, *Syntactic Structures* (1957), contained a detailed analysis of the English system of auxiliary verbs

• It showed how formal analysis could reveal subtle generalizations

• The power of Chomsky’s analysis of auxiliaries was one of the early selling points for transformational grammar
  • Especially, his unified treatment of auxiliary *do*

• So it’s a challenge to any theory of grammar to deal with the same phenomena
Two Approaches to Analyzing Auxiliaries

• Treat auxiliaries as a special category, and formulate specialized transformations sensitive to their presence

• Assimilate their properties to existing types as much as possible, and elaborate the lexicon to handle what is special about them

• We adopt the latter, treating auxiliaries as a subtype of $srv$-$lxm$
Consequences of Making $auxv$-$lxm$ a Subtype of $srv$-$lxm$

- Auxiliaries should express one-place predicates
- Auxiliaries should allow non-referential subjects (dummy $there$, $it$, and idiom chunks)
- Passivization of the main verb (the auxiliary’s complement) should preserve truth conditions
- Are these borne out?
Why call auxiliaries verbs?

- *be, have, and do* exhibit verbal inflections (tense, agreement)

- *be, have, and do* can all appear as main verbs (that is, as the only verb in a sentence)
  - Their inflections are the same in main and auxiliary uses
  - *be* exhibits auxiliary behavior, even in its main verb uses

- Modals (*can, might, will*, etc.) don’t inflect, but they occur in environments requiring a finite verb with no (other) finite verb around.
What’s special about auxiliaries?

• Unlike other subject-raising verbs we have looked at, their complements aren’t introduced by *to*

• The modals and *do* have defective paradigms

• There are restrictions on the ordering and iterability of auxiliaries

• They have a set of special characteristics known as the NICE properties.
### Some Type Constraints

<table>
<thead>
<tr>
<th>TYPE</th>
<th>FEATURES/CONSTRAINTS</th>
<th>IST</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>verb-lxm</code></td>
<td></td>
<td><code>infl-lxm</code></td>
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<tr>
<td><code>srv-lxm</code></td>
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<td><code>verb-lxm</code></td>
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<td><code>ic-srv-lxm</code></td>
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<td><code>srv-lxm</code></td>
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<tr>
<td><code>auxv-lxm</code></td>
<td></td>
<td><code>srv-lxm</code></td>
</tr>
</tbody>
</table>
A Lexical Entry for \textit{be}

\[
\langle \text{be}, \begin{bmatrix}
\text{auxv-lxm} \\
\text{ARG-ST} \\
\text{SEM}
\end{bmatrix}
\begin{bmatrix}
\text{X,} \\
\text{SYN} \\
\text{SEM}
\end{bmatrix}
\begin{bmatrix}
\text{HEAD} \\
\text{INDEX 2}
\end{bmatrix}
\begin{bmatrix}
\text{PRED} +
\end{bmatrix}
\begin{bmatrix}
\text{INDEX 2} \\
\text{RESTR} \langle \rangle
\end{bmatrix}
\rangle
\]

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The Entry for *be*, with Inherited Information

$$
\langle \text{be}, \rangle
$$

$$\begin{aligned}
\text{ARG-ST} & : 3, \\
\text{SYN} & : 3, \\
\text{HEAD} & : \text{verb} + \\
\text{AUX} & : \text{AGR 0} \\
\text{AGR} & : 0 \\
\text{SEM} & : \text{INDEX 2} \\
\text{INDEX} & : 2 \\
\text{RESTR} & : \langle \rangle
\end{aligned}
$$
Entry for have

• Note the FORM restriction on the complement VP
• What accounts for the analogous FORM restriction on verbs following be?
Lexical Entry for a Modal

\[
\langle \text{would}, \langle x, \langle \text{RELN would} \rangle \rangle \rangle
\]

\[
\text{syn} = \begin{bmatrix}
\text{HEAD} & \begin{bmatrix}
\text{form} & \text{fin}
\end{bmatrix}
\end{bmatrix}
\]

\[
\text{arg-st} = \begin{bmatrix}
\text{indexed} & s_1
\end{bmatrix}
\]

\[
\text{sem} = \begin{bmatrix}
\text{restr} & \begin{bmatrix}
\text{sit} & \text{would}
\end{bmatrix}
\end{bmatrix}
\]

\[
\text{auxv-lxm}
\]

- Note the restriction on the form of the complement VP
- What inflectional lexical rules apply to this lexeme?
Accounting for the Basic Facts Cited Earlier

• **Optionality of auxiliaries:**
  As raising verbs, their subjects and complements go together.

• **Auxiliaries precede non-auxiliary verbs:**
  Auxiliaries are heads, and complements follow heads in English.

• **Auxiliaries determine the form of the following verb:**
  This is built into their lexical entries.

• **When auxiliaries co-occur, their order is fixed:**
  Different explanations for different combinations; see next slide.

• **Non-iterability of auxiliaries:**
  Ditto.
Accounting for Restrictions on Order and Iterability

• **Order**
  • Modals are finite, and all auxiliaries take non-finite complements. Hence, modals must come first.
  • Stative verbs (like *own*) don’t have present participles, and auxiliary *have* is stative. Hence, *Pat is having tapdanced.*

• **Iterability**
  • Auxiliary *be* is also stative, so *Pat is being tapdancing.*
  • Modals must be finite, and their complements must be base, so *Pat can should tapdance.*
  • *Pat has had tapdanced* can be ruled out in various ways, e.g. stipulating that auxiliary *have* has no past participle.
Sketch of Chomsky’s Old Analysis

\[
S \rightarrow \text{NP} \ \text{AUX} \ \text{VP} \\
\text{AUX} \rightarrow T(M)(\text{PERF})(\text{PROG})
\]

\[
S \\
\text{NP} \\
\ | \\
\text{Chris} \\
\ | \\
\text{past} \\
\text{could} \\
\text{have+en} \\
\text{be+ing} \\
\text{eat} \\
\text{V} \\
\text{PROG} \\
\text{PERF} \\
\text{M} \\
\text{T} \\
\text{AUX} \\
\text{NP} \\
\text{S}
\]
How this Analysis Handles the Basic Facts

- **Optionality of auxiliaries:**
  Stipulated in the phrase structure rule (with parentheses)

- **Auxiliaries precede non-auxiliary verbs:**
  Built into the phrase structure rule, with AUX before VP

- **Auxiliaries determine the form of the following verb:**
  Inflections are inserted with the auxiliaries and moved onto the following verb transformationally.

- **When auxiliaries co-occur, their order is fixed:**
  Stipulated in the phrase structure rule for AUX

- **Non-iterability of auxiliaries:**
  Ditto.
The two analyses assign very different trees

- *could have been* VP, *have been* VP, and *been* VP are all constituents
- *could have been* is not a constituent

- *could have been* VP, *have been* VP, and *been* VP are not constituents
- *could have been* is a constituent
Ellipsis and Constituency

- Consider:
  
  *Pat couldn’t have been eating garlic, but Chris could have been*

- On the nested analysis, the missing material is a (VP) constituent in each case

- On the flat analysis, the missing material is never a constituent

- This argues for our analysis over the old transformational one.
Our Analysis of Auxiliaries So Far

• Auxiliaries are subject-raising verbs

• Most basic distributional facts about them can be handled through selectional restrictions between auxiliaries and their complements (that is, as ARG-ST constraints)

• Auxiliaries are identified via a HEAD feature AUX, which we have not yet put to use
Descriptive Summary of the NICE Properties

**Negation**
Sentences are negated by putting *not* after the first auxiliary verb; they can be reaffirmed by putting *too* or *so* in the same position.

**Inversion**
Questions are formed by putting an auxiliary verb before the subject NP.

**Contraction**
Auxiliary verbs take negated forms, with *n’t* affixed.

**Ellipsis**
Verb phrases immediately following an auxiliary verb can be omitted.
Negation (and Reaffirmation)

- Polar adverbs (sentential *not*, *so*, and *too*) appear immediately following an auxiliary
  
  *Pat will not leave*
  *Pat will SO leave*
  *Pat will TOO leave*

- What about examples like *Not many people left*?

- What happens when you want to deny or reaffirm a sentence with no auxiliary?
  
  *Pat left*
  *Pat did not leave*
  *Pat did TOO leave*
The Auxiliary *do*

- Like modals, *do* only occurs in finite contexts:
  
  *Pat continued to do not leave*

- Unlike modals, *do* cannot be followed by other auxiliaries:
  
  *Pat did not have left*
The ADV\textsubscript{pol}-Addition Lexical Rule

\[
\begin{align*}
\text{INPUT} & \quad \langle X, \ldots s_1 \rangle \\
\text{ARG-ST} & \quad \langle [ \square ] \oplus [ \square ] \rangle \\
\text{SEM} & \quad [ \text{INDEX} \ s_1 ]
\end{align*}
\]

\[
\begin{align*}
\text{OUTPUT} & \quad \langle Y, \ldots s_2 \rangle \\
\text{ARG-ST} & \quad \langle [ \square ] \oplus [ \square ] \rangle \\
\text{SEM} & \quad [ \text{INDEX} \ s_2 ]
\end{align*}
\]

\[
\begin{align*}
\text{pi-rule} & \\
\text{SYN} & \quad [ \text{HEAD} \ [ \text{verb} \ [ \text{FORM} \ \text{fin} ] ] ] \\
\text{HEAD} & \quad [ \text{POL} \ - ] \\
\text{AUX} & \quad [ \text{POL} \ + ] \\
\text{VAL} & \quad [ \text{SPR} \ [ \langle Z \rangle ] ]
\end{align*}
\]
What does the type *pi-rule* mean?

- It maps words to words (hence, “post-inflectional”)
- It preserves MOD values, HEAD values as a default, and (like other lexical rule types) SEM values as a default
Why doesn’t $ADV_{pol}$-Addition LR mention VAL?

\[
\begin{align*}
\text{INPUT} & : \langle X, \rangle \\
\text{ARG-ST} & : \langle \mathbb{1} \rangle \oplus [A] \\
\text{SEM} & : \langle \text{INDEX } s_1 \rangle \\
\text{SYN} & : \langle \text{HEAD } \begin{bmatrix} \text{verb} \\ \text{FORM } \text{fin} \\ \text{POL } - \\ \text{AUX } + \end{bmatrix} \rangle \\
\text{OUTPUT} & : \langle Y, \rangle \\
\text{ARG-ST} & : \langle \mathbb{1} \rangle \oplus \langle [\text{INDEX } s_2] \rangle \oplus [A] \\
\text{SEM} & : \langle \text{INDEX } s_2 \rangle \\
\text{ADV}_{pol} & : \langle [\text{ARG } s_1] \rangle
\end{align*}
\]
What is the role of these indices?

\[\text{pi-rule}\]

INPUT \[\langle X, \text{SYN} \rangle\]

\[\overset{\text{ARG-ST}}{\langle \text{POL} \rangle} \oplus \overset{\text{SEM}}{\langle \text{INDEX} s_1 \rangle}\]

OUTPUT \[\langle Y, \text{SYN} \rangle\]

\[\overset{\text{ARG-ST}}{\langle \text{POL} \rangle} \oplus \overset{\text{SEM}}{\langle \text{INDEX} s_2 \rangle}\]
Which *nots* does the rule license?

Andy must *not* have been sleeping?

Andy must *have* *not* been sleeping?

Andy must have *been* *not* sleeping?

*Kleptomaniacs cannot* *not* steal.

*Kleptomaniacs cannot* *not* steal.
Negation and Reaffirmation: A Sample Tree

S

NP

Leslie

VP

V

did

ADV_{pol}

so

VP

eat the whole pizza
Inversion

• Yes-no questions begin with an auxiliary:
  \textit{Will Robin win?}

• The NP after the auxiliary has all the properties of a subject
  • Agreement: \textit{Have they left?} vs. \textit{*Has they left?}
  • Case: \textit{*Have them left?}
  • Raising: \textit{Will there continue to be food at the meetings?}

• What happens if you make a question out of a sentence without an auxiliary?
  \textit{Robin won}
  \textit{Did Robin win?}
The Inversion Lexical Rule

\[
\begin{align*}
\text{INPUT} & \quad \left\langle W, \right. \\
\text{ARG-ST} & \quad \text{A} \\
\text{SEM} & \quad \left[ \text{MODE} \quad \text{prop} \right] \\
\text{SYN} & \quad \left[ \begin{array}{c}
\text{HEAD} \\
\text{VAL} \\
\end{array} \right] \\
\end{align*}
\]

\[
\begin{align*}
\text{OUTPUT} & \quad \left\langle Z, \right. \\
\text{ARG-ST} & \quad \text{A} \\
\text{SEM} & \quad \left[ \begin{array}{c}
\text{MODE} \quad \text{ques} \\
\end{array} \right] \\
\text{SYN} & \quad \left[ \begin{array}{c}
\text{HEAD} \\
\text{VAL} \\
\end{array} \right] \\
\end{align*}
\]

\[
\begin{align*}
\text{pi-rule} & \quad \left[ \begin{array}{c}
\text{verb} \\
\text{FORM} \quad \text{fin} \\
\text{AUX} \quad + \\
\text{SPR} \quad \langle \ X \rangle \\
\end{array} \right] \\
\end{align*}
\]
How the Rule Yields Inverted Order

...plus the ARP
The Feature INV

• What is the INV value of inputs to the Inversion LR?
  • Perhaps surprisingly, the input is [INV +]
  • Word-to-word rules (*pi-rules*) have default identity of HEAD features, and no INV value is given on the input

• Then what work is the feature doing?
  • It’s used to mark auxiliaries that can’t or must be inverted

  *You better watch out* vs. *Better you watch out*

  *I shall go* (shall ~ ‘will’) vs. *Shall I go?* (shall ~ ‘should’)

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Other Cases of Inversion

• Inversion is not limited to questions
  • Preposed negatives: *Never have I been so upset!*
  • Conditionals: *Had we known, we would have left.*
  • Exclamations: *May your teeth fall out!*

• Does our rule account for these?
  • No. Our rule’s output says [MODE ques]. And each construction has slightly different idiosyncrasies.

• How might we extend our analysis to cover them?
  • Define a type of inversion lexical rules, sharing certain properties, but with some differences.
Inversion: A Sample Tree

S

V

NP

VP

Did

Leslie

eat the entire pizza?
Contraction

• There are several types of contraction in English, but we’re only talking about words ending in *n’t*

• It may seem like just *not* said fast, but there’s more to it
  • Only finite verbs can take *n’t*:
    *Terry must haven’t seen us*

• There are morphological irregularities:
  *won’t*, not *willn’t*  %*shan’t*, not *shalln’t*
  *mustn’t* pronounced *mussn’t*
  *don’t* pronounced *doesn’t*, not *dewn’t*
  *amn’t*
The Contraction Lexical Rule

\[
\begin{align*}
&\text{INPUT} \quad \left\langle \begin{array}{c}
\text{ARG-ST} \quad \text{B} \\
\text{SEM} & \begin{bmatrix}
\text{INDEX} & s_1 \\
\text{RESTR} & \text{A}
\end{bmatrix}
\end{array} \rightangle, \\
\text{SYN} & \begin{bmatrix}
\text{HEAD} & \begin{bmatrix}
\text{verb} \\
\text{FORM} & \text{fin} \\
\text{AUX} & + \\
\text{POL} & -
\end{bmatrix}
\end{bmatrix}
\end{align*}
\]

\[
\begin{align*}
&\text{OUTPUT} \quad \left\langle \begin{array}{c}
\text{ARG-ST} \quad \text{B} \\
\text{SEM} & \begin{bmatrix}
\text{INDEX} & s_2 \\
\text{RESTR} & \begin{bmatrix}
\text{RELN} & \text{not} \\
\text{SIT} & s_2 \\
\text{ARG} & s_1
\end{bmatrix}
\end{bmatrix}
\end{array} \rightangle \\
\quad \left\langle \begin{array}{c}
\text{SYN} & \begin{bmatrix}
\text{HEAD} & \begin{bmatrix}
\text{POL} & +
\end{bmatrix}
\end{bmatrix} \\
\text{VAL} & \begin{bmatrix}
\text{SPR} & \langle \text{X} \rangle
\end{bmatrix}
\end{array} \rightangle
\end{align*}
\]
Most of the work is in the semantics

Why?
What does POL do?

*We can’tn’t stop
*They won’t TOO mind
Contraction: Sample Tree

S

NP

Leslie

VP

V

wouldn’t

VP

eat the entire pizza
Ellipsis

• Ellipsis allows VPs to be omitted, so long as they would have been preceded by an auxiliary

  *Pat couldn’t have been watching us, but Chris could have been watching us.*

• Unlike the other NICE properties, this holds of all auxiliaries, not just finite ones.

• What is the elliptical counterpart to a sentence with no auxiliary?

  *Whenever Pat watches TV, Chris watches TV  Whenever Pat watches TV, Chris does*
The Ellipsis Lexical Rule

\[
\begin{align*}
\text{INPUT} & \quad \left< 1, \left[ \begin{array}{c}
\text{auxv-lxm} \\
\text{ARG-ST} \left< 2 \right> \oplus \text{A}
\end{array} \right] \right> \\
\text{OUTPUT} & \quad \left< 1, \left[ \begin{array}{c}
\text{derivv-lxm} \\
\text{ARG-ST} \left< 2 \right>
\end{array} \right] \right>
\end{align*}
\]

• Note that this is a derivational LR \((d\text{-}rule)\) -- that is, lexeme-to-lexeme

• This means that SYN and SEM are unchanged, by default
Ellipsis: A Sample Output

\[
\langle \text{could} , \text{auxv-lxm} \rangle
\]

\[
\begin{align*}
\text{SYN} & \quad \text{HEAD} & \quad \text{VAL} \\
\text{ARG-ST} & \quad \langle \text{NP} \rangle & & \quad \text{FORM fin} \\
\text{SEM} & \quad \text{MODE prop} & \quad \text{INDEX s}_1 \\
\text{RESTR} & \quad \langle \text{RELN could} \rangle \\
\end{align*}
\]
Kim could have been attending the conference.
Semantics of Ellipsis

What is the SEM value of the S node of this tree?

\[
\begin{aligned}
\text{INDEX} & \quad s_1 \\
\text{MODE} & \quad \text{prop} \\
\text{RESTR} & \quad \left< \begin{bmatrix} \text{RELN} & \text{name} \\ \text{NAME} & \text{Kim} \\ \text{NAMED} & i \end{bmatrix}, \begin{bmatrix} \text{RELN} & \text{could} \\ \text{SIT} & s_1 \\ \text{ARG} & s_2 \end{bmatrix} \right> \\
\end{aligned}
\]

Note: \(s_2\) has to be filled in by context.
Infinitival *to* Revisited

• VP Ellipsis can occur after *to*:

  *We didn’t find the solution, but we tried to.*

• This is covered by our Ellipsis LR if we say *to* is [AUX +].

• Since AUX is declared on type *verb*, it follows that *to* is a verb.
**do Revisited**

- Chomsky’s old analysis: in sentences w/o auxiliaries...
  - Tense can get separated from the verb in various ways
  - Negation/Reaffirmation inserts something between Tense and the following verb
  - Inversion moves Tense to the left of the subject NP
  - Ellipsis deletes what follows Tense
  - When this happens, *do* is inserted to support Tense

- Our counterpart:
  - NICE properties hold only of auxiliaries
  - *do* is a semantically empty auxiliary, so negated, reaffirmed, inverted, and elliptical sentences that are the semantic counterparts to sentences w/o auxiliaries are ones with *do*. 
Summary

• Our analysis employs straightforward mechanisms
  • Lexical entries for auxiliaries
  • 3 new features (AUX, POL, INV)
  • 4 lexical rules

• We handle a complex array of facts
  • co-occurrence restrictions (ordering & iteration)
  • the NICE properties
  • auxiliary *do*
  • combinations of NICE constructions