Ling 566
Nov 23, 2009
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
Some Basic Facts about Auxiliaries

- They are optional
  
  *Pat tapdanced. Pat can tapdance. Pat is tapdancing.*

- They precede any non-auxiliary verbs
  
  *Pat tapdance can. *Pat tapdancing is.*

- They determine the form of the following verb
  
  *Pat can tapdancing. *Pat is tapdance.*

- When they co-occur, their order is fixed
  
  *Pat must be tapdancing. *Pat is musting tapdance.*

- Auxiliaries of any given type cannot iterate
  
  *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 \textit{auxv-lxm} a Subtype of \textit{srv-lxm}

- Auxiliaries should express one-place predicates
- Auxiliaries should allow non-referential subjects (dummy \textit{there}, \textit{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>
</table>
| verb-lxm   | SYN \[
|            | \quad \text{HEAD} \quad \begin{bmatrix}
|            | \quad \text{verb} \\
|            | \quad \text{AUX} \\
|            | \quad / -
|            | \end{bmatrix}\]
|            | ARG-ST \langle [\text{HEAD}\nominal], \ldots \rangle \]
|            | SEM \quad \begin{bmatrix}
|            | \quad \text{MODE} \\
|            | \quad \text{prop}
|            | \end{bmatrix}\] | infl-lxm |
| srv-lxm    | ARG-ST \langle \begin{bmatrix}
|            | \quad 1 \\
|            | \quad [\text{SPR}\langle 1 \rangle]
|            | \quad \text{COMPS}\langle \rangle
|            | \end{bmatrix}\rangle | verb-lxm |
| ic-srv-lxm | ARG-ST \langle \begin{bmatrix}
|            | \quad X \\
|            | \quad [\text{INF}\langle \rangle]
|            | \quad +
|            | \quad \text{INDEX}\langle s \rangle
|            | \end{bmatrix}\rangle \]
|            | SEM \quad \begin{bmatrix}
|            | \quad \text{RESTR}\langle [\text{ARG}\langle s \rangle]\rangle
|            | \end{bmatrix}\] | srv-lxm  |
| auxv-lxm   | SYN \quad \begin{bmatrix}
|            | \quad \text{HEAD} \\
|            | \quad [\text{AUX}\langle +\rangle]
|            | \end{bmatrix}\] | srv-lxm  |
A Lexical Entry for *be*

\[
\langle \text{be}, \left[ auxv-lxm \right. \rangle
\]

\[
\langle \text{ARG-ST} \rangle \left[ X, \left[ SYN \left[ \text{HEAD} \left[ \text{PRED} + \right] \right] \right] \right] \rangle
\]

\[
\langle \text{SEM} \left[ \text{INDEX} 2 \right] \left[ \text{RESTR} \langle \rangle \right] \rangle
\]
The Entry for \textit{be}, with Inherited Information

\begin{align*}
\langle \text{be}, \rangle & \quad \langle 3, \rangle
\end{align*}

\begin{align*}
\langle \text{be}, \rangle & \quad \langle 3, \rangle
\end{align*}

\begin{align*}
\langle \text{be}, \rangle & \quad \langle 3, \rangle
\end{align*}

\begin{align*}
\langle \text{be}, \rangle & \quad \langle 3, \rangle
\end{align*}
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

• 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

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

\[ S \]
\[ NP \]
\[ Chris \]
\[ AUX \]
\[ T \]
\[ past \]
\[ M \]
\[ could \]
\[ PERF \]
\[ have+en \]
\[ PROG \]
\[ be+ing \]
\[ VP \]
\[ eat \]
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:

\[ Pat \text{ couldn’t have been eating garlic, but Chris could have been } \]
\[ Pat \text{ couldn’t have been eating garlic, but Chris could have been } \]
\[ Pat \text{ couldn’t have been eating garlic, but Chris could } \]

• 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

<table>
<thead>
<tr>
<th>N</th>
<th>negation</th>
<th>Sentences are negated by putting <em>not</em> after the first auxiliary verb; they can be reaffirmed by putting <em>too</em> or <em>so</em> in the same position</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Inversion</td>
<td>Questions are formed by putting an auxiliary verb before the subject NP</td>
</tr>
<tr>
<td>C</td>
<td>Contraction</td>
<td>Auxiliary verbs take negated forms, with <em>n’t</em> affixed</td>
</tr>
<tr>
<td>E</td>
<td>Ellipsis</td>
<td>Verb phrases immediately following an auxiliary verb can be omitted</td>
</tr>
</tbody>
</table>
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

\[
\begin{align*}
\text{INPUT} & \left\langle X, \right. \\
\text{ARG-ST} & \left\langle 1 \right. \oplus \left. \text{A} \right. \\
\text{SEM} & \left[ \text{INDEX} \ s_1 \right] \\
\text{OUTPUT} & \left\langle Y, \right. \\
\text{ARG-ST} & \left\langle 1 \right. \oplus \left. \left[ \text{INDEX} \ s_2 \right] \right. \\
\text{SEM} & \left[ \text{INDEX} \ s_2 \right]
\end{align*}
\]
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

\[
\begin{align*}
\text{INPUT} & \quad \langle / \quad \text{word} \quad \text{ SYN } \quad \text{ HEAD } / \quad 1 \quad \text{ VAL } \quad \text{ MOD } [A] \quad \text{SEM} / \quad 2 \quad \rangle \\
\text{OUTPUT} & \quad \langle / \quad \text{word} \quad \text{ SYN } \quad \text{ HEAD } / \quad 1 \quad \text{ VAL } \quad \text{ MOD } [A] \quad \text{SEM} / \quad 2 \quad \rangle
\end{align*}
\]
Why doesn't $\text{ADV}_{pol}$-Addition LR mention VAL?

\[
\begin{align*}
\text{INPUT} & \quad \langle x, \rangle \\
\text{ARG-ST} & \quad \langle 1 \rangle \oplus \text{A} \\
\text{SEM} & \quad \begin{bmatrix} \text{INDEX} & s_1 \end{bmatrix}
\end{align*}
\]

\begin{align*}
\text{SYN} & \quad \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \text{verb} \\ \text{FORM} & \text{fin} \\ \text{POL} & - \\ \text{AUX} & + \end{bmatrix} \end{bmatrix} \\
\text{SEM} & \quad \begin{bmatrix} \text{INDEX} & s_1 \end{bmatrix}
\end{align*}

\begin{align*}
\text{OUTPUT} & \quad \langle y, \rangle \\
\text{ARG-ST} & \quad \langle 1 \rangle \oplus \begin{bmatrix} \text{INDEX} & s_2 \\ \text{RESTR} & \langle \text{ARG} & s_1 \rangle \end{bmatrix} \oplus \text{A} \\
\text{SEM} & \quad \begin{bmatrix} \text{INDEX} & s_2 \end{bmatrix}
\end{align*}

\text{pi-rule}
What is the role of these indices?
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

NP
  |  V
Leslie  did

VP
  |  ADV_{pol}
  |  so
  VP
  |  eat the whole pizza
Inversion

- Yes-no questions begin with an auxiliary: 
  *Will Robin win?*

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

- What happens if you make a question out of a sentence without an auxiliary?
  *Robin won*
  *Did Robin win?*
The Inversion Lexical Rule

\[ \text{pi-rule} \]

INPUT \( W \) ,  
\[
\begin{array}{c}
\text{SYN} \\
\text{ARG-ST} \\
\text{SEM}
\end{array}
\]

\[
\begin{array}{c}
\left[ \begin{array}{c}
\text{HEAD} \\
\text{VAL}
\end{array} \right]
\end{array}
\]

\[
\begin{array}{c}
\left[ \begin{array}{c}
\text{FORM} \\
\text{AUX} \\
\text{SPR} \langle X \rangle
\end{array} \right]
\end{array}
\]

\[
\begin{array}{c}
\left[ \begin{array}{c}
\text{MODE} \\
\text{prop}
\end{array} \right]
\end{array}
\]

OUTPUT \( Z \) ,  
\[
\begin{array}{c}
\text{SYN} \\
\text{ARG-ST} \\
\text{SEM}
\end{array}
\]

\[
\begin{array}{c}
\left[ \begin{array}{c}
\text{HEAD} \\
\text{VAL}
\end{array} \right]
\end{array}
\]

\[
\begin{array}{c}
\left[ \begin{array}{c}
\text{INV} \\
\text{SPR} \langle \rangle
\end{array} \right]
\end{array}
\]

\[
\begin{array}{c}
\left[ \begin{array}{c}
\text{MODE} \\
\text{ques}
\end{array} \right]
\end{array}
\]
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
    
    \( \textit{You better watch out} \) vs. \( *\textit{Better you watch out} \)

    \( \textit{I shall go} \) (\( \textit{shall} \sim \text{‘will’} \)) vs. \( \textit{Shall I go?} \) (\( \textit{shall} \sim \text{‘should’} \))
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

Did

NP

Leslie

VP

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

\[ \text{pi-rule} \]

\[
\begin{aligned}
\text{INPUT} & \langle 2 \rangle, \\
\text{ARG-ST} & \Box, \\
\text{SYN} & \begin{bmatrix}
\text{HEAD} \\
\text{FORM}
\end{bmatrix}, \\
\text{SEM} & \begin{bmatrix}
\text{INDEX} \\
\text{RESTR}
\end{bmatrix}, \\
\text{ARG-ST} & \Box, \\
\text{OUTPUT} & \langle F_{\text{NEG}}(2) \rangle, \\
\text{ARG-ST} & \Box, \\
\text{INDEX} & s_2, \\
\text{SEM} & \begin{bmatrix}
\text{RESTR} \\
\text{RELN}
\end{bmatrix}, \\
\text{ARG} & s_1, \\
\text{SIT} & s_2, \\
\end{aligned}
\]
Most of the work is in the semantics

<table>
<thead>
<tr>
<th>pi-rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>INPUT</td>
</tr>
<tr>
<td>SYN</td>
</tr>
<tr>
<td>HEAD</td>
</tr>
<tr>
<td>verb</td>
</tr>
<tr>
<td>FORM</td>
</tr>
<tr>
<td>fin</td>
</tr>
<tr>
<td>AUX</td>
</tr>
<tr>
<td>+</td>
</tr>
<tr>
<td>POL</td>
</tr>
<tr>
<td>-</td>
</tr>
<tr>
<td>ARG-ST</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>INDEX</td>
</tr>
<tr>
<td>s₁</td>
</tr>
<tr>
<td>SEM</td>
</tr>
<tr>
<td>RESTR</td>
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<tr>
<td>[A]</td>
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<table>
<thead>
<tr>
<th>OUTPUT</th>
</tr>
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<tbody>
<tr>
<td>SYN</td>
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<tr>
<td>HEAD</td>
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<tr>
<td>POL</td>
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<td>+</td>
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<tr>
<td>VAL</td>
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<td>[SPR</td>
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<td>ARG-ST</td>
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<td>INDEX</td>
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<td>s₂</td>
</tr>
<tr>
<td>SEM</td>
</tr>
<tr>
<td>RESTR</td>
</tr>
<tr>
<td>[RELN</td>
</tr>
<tr>
<td>not</td>
</tr>
<tr>
<td>[ARG</td>
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<tr>
<td>s₁</td>
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<td>[SIT</td>
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<td>s₂</td>
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<td>]</td>
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<td>]</td>
</tr>
<tr>
<td>⊕</td>
</tr>
<tr>
<td>[A]</td>
</tr>
</tbody>
</table>

Why?
What does POL do?

INPUT \( \langle 2, \underline{B}, s_1 \rangle \)

OUTPUT \( \langle F_{NEG}(2), \underline{B}, s_2 \rangle \)

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

S
/   \\  
NP  VP
    /   \\
   Leslie V VP \\
        /  \\
      wouldn’t 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

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

- Note that this is a derivational LR (\textit{d-rule}) -- that is, lexeme-to-lexeme
- This means that SYN and SEM are unchanged, by default
Ellipsis: A Sample Output

\[
\langle \text{could},
\begin{array}{c}
\text{auxv-lxm} \\
\text{SYN} \\
\text{ARG-ST} \\
\text{SEM}
\end{array}
\begin{array}{c}
\text{HEAD} \\
\text{VAL} \\
\text{MODE} \\
\text{INDEX}
\end{array}
\begin{array}{c}
\begin{bmatrix}
\text{FORM} & \text{fin} \\
\text{AUX} & + \\
\text{POL} & - \\
\text{AGR} & 1 \\
\end{bmatrix} \\
\begin{bmatrix}
\text{SPR} & \langle [\text{AGR} 1] \rangle
\end{bmatrix}
\begin{bmatrix}
\text{prop} & s_1 \\
\end{bmatrix}
\begin{bmatrix}
\text{RELN} & \text{could} \\
\text{SIT} & s_1 \\
\text{ARG} & s_2
\end{bmatrix}
\end{array}\rangle
\]
Ellipsis: A Sample Tree

S

NP

Kim

VP

V

could

V

have

V

been

VP

attending the conference
Semantics of Ellipsis

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

\[
\begin{align*}
&\text{INDEX } s_1 \\
&\text{MODE } \text{prop} \\
&\text{RESTR} \langle \begin{bmatrix} \text{NAME} & \text{Kim} \\ \text{NAMED} & i \end{bmatrix}, \begin{bmatrix} \text{RELN} & \text{could} \\ \text{SIT} & s_1 \\ \text{ARG} & s_2 \end{bmatrix} \rangle
\end{align*}
\]

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 \([\text{AUX } +]\).

- 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