Ling 566
Nov 2, 2021

Lexical Rules

© 2003 CSLI Publications

Overview

- How lexical rules fit in
- Three types of lexical rules, constraints
- Example: Plural noun lexical rule
- Advice on writing lexical rules
- Constant lexemes
- ARG-ST & ARP
- The feature FORM

© 2003 CSLI Publications

Lexical Types & Lexical Rules

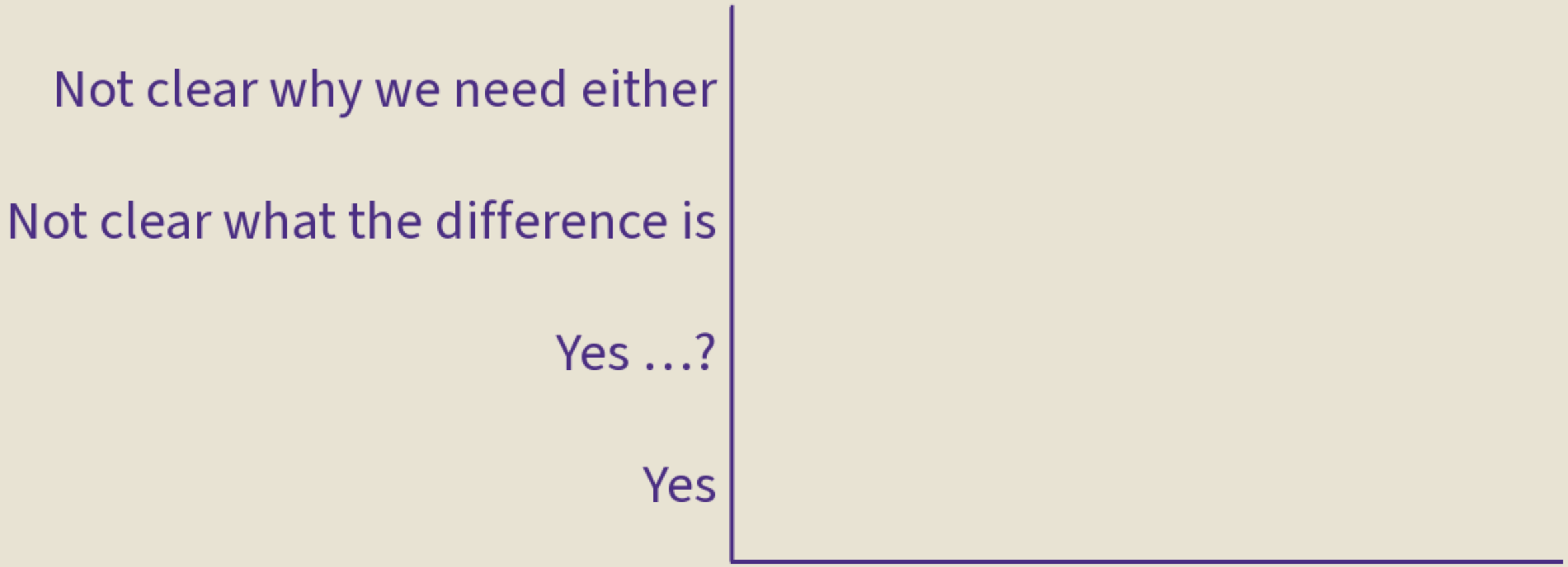
- Lexemes capture the similarities among *run*, *runs*, *running*, and *ran*
- The lexical type hierarchy captures the similarities among *run*, *sleep*, and *laugh*, among those and other verbs like *devour* and *hand*, and among those and other words like *book*.
- Lexical rules capture the similarities among *runs*, *sleeps*, *devours*, *hands*, ...

© 2003 CSLI Publications

When poll is active, respond at **pollev.com/emb**

Text **EMB** to **22333** once to join

Is it clear what type of regularities are captured by lexical types and lexical rules? (take 3)



Start the presentation to see live content. For screen share software, share the entire screen. Get help at **pollev.com/app**

Parsimony & Plausibility

- Lexical rules capture **productive** generalizations.
- There may be some ‘precompiling’ going on as well.

© 2003 CSLI Publications

Three Kinds of Lexical Rules

- Inflectional: *lexeme* to *word*

Examples?

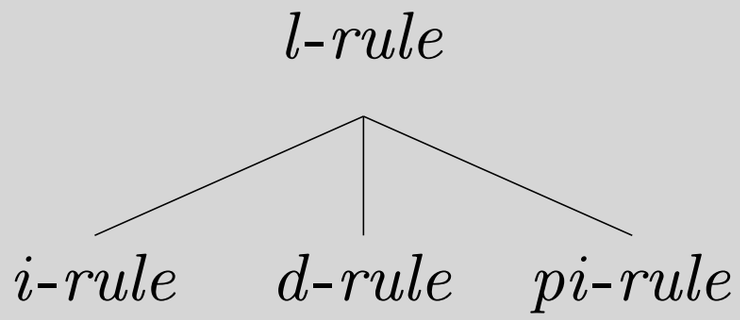
- Derivational: *lexeme* to *lexeme*

Examples?

- Post-Inflectional: *word* to *word*
  (Chapters 11, 13, 14)

© 2003 CSLI Publications

Three Subtypes of *l-rule*



$$\textit{l-rule}: \begin{bmatrix} \text{INPUT} & \textit{l-sequence}\left\langle \text{X} , [\ \text{SEM} \quad / \boxed{2}\ ] \right\rangle \\ \text{OUTPUT} & \textit{l-sequence}\left\langle \text{Y} , [\ \text{SEM} \quad / \boxed{2}\ ] \right\rangle \end{bmatrix}$$

$$\textit{i-rule}: \begin{bmatrix} \text{INPUT} & \left\langle \text{X} , \begin{bmatrix} \textit{lexeme} \\ \text{SYN} \quad \boxed{3} \\ \text{ARG-ST} \quad \boxed{\text{A}} \end{bmatrix} \right\rangle \\ \text{OUTPUT} & \left\langle \text{Y} , \begin{bmatrix} \textit{word} \\ \text{SYN} \quad \boxed{3} \\ \text{ARG-ST} \quad \boxed{\text{A}} \end{bmatrix} \right\rangle \end{bmatrix}$$

$$\textit{d-rule}: \begin{bmatrix} \text{INPUT} & \left\langle \text{X} , \begin{bmatrix} \textit{lexeme} \\ \text{SYN} \quad / \boxed{3} \end{bmatrix} \right\rangle \\ \text{OUTPUT} & \left\langle \text{Y} , \begin{bmatrix} \textit{lexeme} \\ \text{SYN} \quad / \boxed{3} \end{bmatrix} \right\rangle \end{bmatrix}$$

© 2003 CSLI Publications

Plural Noun LR

$$\left[\begin{array}{l} \textit{i-rule} \\ \text{INPUT} \quad \left\langle \boxed{1}\ ,\ \textit{cntn-lxm} \right\rangle \\ \text{OUTPUT} \quad \left\langle \text{F}_{NPL}(\boxed{1})\ ,\ \left[\begin{array}{l} \textit{word} \\ \text{SYN} \left[\text{HEAD} \quad \left[\text{AGR} \quad \left[\text{NUM} \quad \text{pl}\right]\right]\right] \end{array}\right] \right\rangle \end{array}\right]$$

© 2003 CSLI Publications

Plural Noun LR with Inherited Constraints

$$
\left[\begin{array}{l}
\textit{i-rule} \\
\\
\text{INPUT} \quad \left\langle \boxed{1}, \left[\begin{array}{l} \textit{cntn-lxm} \\ \\ \\ \end{array}\right] \right\rangle \\
\\
\text{OUTPUT} \quad \left\langle \mathrm{F}_{NPL}(\boxed{1}), \left[\begin{array}{ll} \textit{word} & \\ & \left[\text{HEAD} \quad [\text{AGR} \quad [\text{NUM} \quad \text{pl}]]\right] \\ & \end{array}\right] \right\rangle
\end{array}\right]
$$

© 2003 CSLI Publications

Plural Noun LR with Inherited Constraints

$$
\left[\begin{array}{l}
\textit{i-rule} \\
\\
\text{INPUT} \quad \left\langle \boxed{1}, \left[\begin{array}{l} \textit{cntn-lxm} \\ \\ \text{SEM} \quad \boxed{2} \end{array}\right] \right\rangle \\
\\
\text{OUTPUT} \quad \left\langle \mathrm{F}_{NPL}(\boxed{1}), \left[\begin{array}{l} \textit{word} \\ \\ \text{SEM} \quad \boxed{2} \end{array}\right. \right. \\
\left. \left. \left[\text{HEAD} \quad [\text{AGR} \quad [\text{NUM} \quad \text{pl}]]\right] \right] \right\rangle
\end{array}\right]
$$

© 2003 CSLI Publications

Plural Noun LR with Inherited Constraints

$$
\left[\begin{array}{l}
\textit{i-rule} \\
\\
\text{INPUT} \quad \left\langle \boxed{1}, \left[\begin{array}{ll}
\textit{cntn-lxm} & \\
 & \\
 & \\
\text{SEM} & \boxed{2} \\
\text{ARG-ST} & \boxed{B} \oplus \boxed{C}
\end{array}\right] \right\rangle \\
\\
\text{OUTPUT} \quad \left\langle \text{F}_{NPL}(\boxed{1}), \left[\begin{array}{ll}
\textit{word} & \\
 & \left[\text{HEAD} \quad [\text{AGR} \quad [\text{NUM} \quad \text{pl}]]\right] \\
 & \\
\text{SEM} & \boxed{2} \\
\text{ARG-ST} & \boxed{B} \oplus \boxed{C}
\end{array}\right] \right\rangle
\end{array}\right]
$$

© 2003 CSLI Publications

Plural Noun LR with Inherited Constraints

$$
\left[\begin{array}{l}
\textit{i-rule} \\
\\
\text{INPUT} \quad \left\langle \boxed{1}, \left[\begin{array}{ll}
\textit{cntn-lxm} & \\
 & \\
\text{SYN} & \boxed{3} \\
 & \\
\text{SEM} & \boxed{2} \\
\text{ARG-ST} & \boxed{B} \oplus \boxed{C}
\end{array}\right] \right\rangle \\
\\
\text{OUTPUT} \quad \left\langle \text{F}_{NPL}(\boxed{1}), \left[\begin{array}{ll}
\textit{word} & \\
 & \\
\text{SYN} & \boxed{3}\left[\text{HEAD} \quad [\text{AGR} \quad [\text{NUM} \quad \text{pl}]]\right] \\
 & \\
\text{SEM} & \boxed{2} \\
\text{ARG-ST} & \boxed{B} \oplus \boxed{C}
\end{array}\right] \right\rangle
\end{array}\right]
$$

© 2003 CSLI Publications

Plural Noun LR with Inherited Constraints

$$\left[\begin{array}{l} \textit{i-rule} \\ \\ \text{INPUT} \quad \left\langle \boxed{1}, \left[\begin{array}{ll} \textit{cntn-lxm} & \\ \\ \text{SYN} & \boxed{3}\left[\begin{array}{ll} \text{HEAD} & \left[\begin{array}{ll} \textit{noun} & \\ \text{AGR} & \boxed{4}[\text{PER} \quad \text{3rd}] \end{array}\right] \\ \\ \text{VAL} & \left[\text{SPR} \quad \left\langle \left[\begin{array}{ll} & \text{DP} \\ \text{COUNT} & + \\ \text{AGR} & \boxed{4} \end{array}\right] \right\rangle\right] \end{array}\right] \\ \text{SEM} & \boxed{2}[\text{MODE} \ / \ \text{ref}] \\ \text{ARG-ST} & \boxed{B} \oplus \boxed{C} \end{array}\right] \right\rangle \\ \\ \text{OUTPUT} \quad \left\langle \text{F}_{NPL}(\boxed{1}), \left[\begin{array}{ll} \textit{word} & \\ \\ \text{SYN} & \boxed{3}\left[\text{HEAD} \quad [\text{AGR} \quad [\text{NUM} \quad \text{pl}]]\right] \\ \\ \text{SEM} & \boxed{2} \\ \text{ARG-ST} & \boxed{B} \oplus \boxed{C} \end{array}\right] \right\rangle \end{array}\right]$$

© 2003 CSLI Publications

Plural Noun LR with Inherited Constraints

$$\left[\begin{array}{l}
\textit{i-rule} \\
\\
\text{INPUT} \quad \left\langle \boxed{1}, \left[\begin{array}{ll}
\textit{cntn-lxm} & \\
\\
\text{SYN} & \boxed{3}\left[\begin{array}{ll}
\text{HEAD} & \left[\begin{array}{ll} \textit{noun} & \\ \text{AGR} & \boxed{4}[\text{PER} \quad \text{3rd}] \end{array}\right] \\
\\
\text{VAL} & \left[\text{SPR} \left\langle \left[\begin{array}{ll} \text{COUNT} & + \\ \text{AGR} & \boxed{4} \end{array}\right] \right\rangle_{\text{DP}}\right]
\end{array}\right] \\
\\
\text{SEM} & \boxed{2}[\text{MODE} \ / \ \text{ref}] \\
\text{ARG-ST} & \boxed{B} \oplus \boxed{C}
\end{array}\right] \right\rangle \\
\\
\text{OUTPUT} \quad \left\langle \text{F}_{NPL}(\boxed{1}), \left[\begin{array}{ll}
\textit{word} & \\
\\
\text{SYN} & \boxed{3}\left[\begin{array}{ll}
\text{HEAD} & [\text{AGR} \quad [\text{NUM} \quad \text{pl}]] \\
\\
\text{VAL} & \left[\begin{array}{ll} \text{SPR} & \boxed{B} \\ \text{COMPS} & \boxed{C} \end{array}\right]
\end{array}\right] \\
\\
\text{SEM} & \boxed{2} \\
\text{ARG-ST} & \boxed{B} \oplus \boxed{C}
\end{array}\right] \right\rangle
\end{array}\right]$$

© 2003 CSLI Publications

Practicalities - Applying Lexical Rules

- INPUT is a family of lexical sequences.
- OUTPUT is another family of lexical sequences.
  - ...usually a smaller family
  - ...usually a disjoint one
- The only differences between the families are those stipulated in the rule (or the rule's type).
- Similarities are handled by the constraints on *l-rule* and its subtypes.
- If we've written the LRs correctly, nothing is left underconstrained.

© 2003 CSLI Publications

Example: Lexical Entry for *cat*

$$\left\langle \text{cat} \;,\; \left[\begin{array}{l} \textit{cntn-lxm} \\ \\ \text{SEM} \end{array} \right. \left[\begin{array}{ll} \text{INDEX} & k \\ \\ \text{RESTR} & \left\langle \left[\begin{array}{ll} \text{RELN} & \text{cat} \\ \text{INST} & k \end{array} \right] \right\rangle \end{array} \right] \right\rangle$$

© 2003 CSLI Publications

Example: *cat*, with inheritance

$$\left\langle \text{cat}\ ,\ \begin{bmatrix} \textit{cntn-lxm} & \\ \text{SYN} & \begin{bmatrix} \text{VAL} & \begin{bmatrix} \quad \end{bmatrix} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{INDEX} & k \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \text{cat} \\ \text{INST} & k \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

© 2003 CSLI Publications

Example: *cat*, with inheritance

$$\left\langle \text{cat} , \left[\textit{cntn-lxm} \right. \right.$$

$$\text{SYN} \left[\text{VAL} \left[\text{SPR} \left\langle \left[\text{COUNT} \quad + \right] \right\rangle \right] \right]$$

$$\left. \text{SEM} \left[\begin{array}{ll} \text{INDEX} & k \\ \text{RESTR} & \left\langle \left[\begin{array}{ll} \text{RELN} & \text{cat} \\ \text{INST} & k \end{array} \right] \right\rangle \end{array} \right] \right] \right\rangle$$

© 2003 CSLI Publications

Example: *cat*, with inheritance

$$\left\langle \text{cat} , \left[\begin{array}{l} \textit{cntn-lxm} \\ \text{SYN} \left[\begin{array}{ll} \text{HEAD} & \left[\begin{array}{ll} \textit{noun} & \\ \text{AGR} & [\ \text{PER} \quad \text{3rd}\ ] \end{array}\right] \\ \text{VAL} & \left[\begin{array}{ll} \text{SPR} & \left\langle \left[\begin{array}{ll} \text{DP} & \\ \text{COUNT} & + \end{array}\right] \right\rangle \\ & \end{array}\right] \end{array}\right] \\ \text{SEM} \left[\begin{array}{ll} \text{MODE} & \text{ref} \\ \text{INDEX} & k \\ \text{RESTR} & \left\langle \left[\begin{array}{ll} \text{RELN} & \text{cat} \\ \text{INST} & k \end{array}\right] \right\rangle \end{array}\right] \\ \text{ARG-ST} \quad \left\langle \text{X} \right\rangle \end{array}\right] \right\rangle$$

© 2003 CSLI Publications

Example: *cat*, with inheritance

$$\left\langle \text{cat} , \left[\begin{array}{l} \textit{cntn-lxm} \\ \text{SYN} \left[\begin{array}{ll} \text{HEAD} & \left[\begin{array}{ll} \textit{noun} & \\ \text{AGR} & \boxed{7}\,[\ \text{PER} \quad \text{3rd}\ ] \end{array}\right] \\ \text{VAL} & \left[\begin{array}{ll} \text{SPR} & \left\langle \left[\begin{array}{ll} & \text{DP} \\ \text{COUNT} & + \\ \text{AGR} & \boxed{7} \end{array}\right] \right\rangle \end{array}\right] \end{array}\right] \\ \text{SEM} \left[\begin{array}{ll} \text{MODE} & \text{ref} \\ \text{INDEX} & k \\ \text{RESTR} & \left\langle \left[\begin{array}{ll} \text{RELN} & \text{cat} \\ \text{INST} & k \end{array}\right] \right\rangle \end{array}\right] \\ \text{ARG-ST} \quad \langle \text{X} \rangle \end{array}\right] \right\rangle$$

© 2003 CSLI Publications

Plural Noun LR

$$\left[\begin{array}{l} \textit{i-rule} \\ \text{INPUT} \quad \left\langle \boxed{1}\ ,\ \textit{cntn-lxm} \right\rangle \\ \text{OUTPUT} \quad \left\langle \text{F}_{NPL}(\boxed{1})\ ,\ \left[\begin{array}{l} \textit{word} \\ \text{SYN} \left[\text{HEAD} \quad \left[\text{AGR} \quad \left[\text{NUM} \quad \text{pl}\right]\right]\right] \end{array}\right] \right\rangle \end{array}\right]$$

© 2003 CSLI Publications

Licensing *cats*

$$\left[\begin{array}{l}\textit{i-rule}\\ \\ \text{INPUT}\quad \left\langle \boxed{1}\text{cat}\ ,\ \left[\begin{array}{ll}\textit{cntn-lxm}\\ \\ \text{SYN} & \boxed{3}\left[\begin{array}{ll}\text{HEAD} & \left[\begin{array}{ll}\textit{noun}\\ \text{AGR} & \boxed{7}[\ \text{PER}\quad \text{3rd}\ ]\end{array}\right]\\ \text{VAL} & \left[\text{SPR}\ \left\langle \left[\begin{array}{ll}\text{COUNT} & +\\ \text{AGR} & \boxed{7}\end{array}\right]\right\rangle\right]\end{array}\right]\\ \text{SEM} & \boxed{2}\left[\begin{array}{ll}\text{MODE} & \text{ref}\\ \text{INDEX} & k\\ \text{RESTR} & \left\langle \left[\begin{array}{ll}\text{RELN} & \text{cat}\\ \text{INST} & k\end{array}\right]\right\rangle\end{array}\right]\\ \text{ARG-ST} & \boxed{B}\langle\ \text{X}\ \rangle \oplus \boxed{C}\langle\ \rangle\end{array}\right]\right\rangle\\ \\ \text{OUTPUT}\quad \left\langle \text{F}_{NPL}(\boxed{1})\ ,\ \left[\begin{array}{ll}\textit{word}\\ \\ \text{SYN} & \boxed{3}\left[\begin{array}{ll}\text{HEAD} & [\text{AGR}\quad [\text{NUM}\quad \text{pl}]]\\ \text{VAL} & \left[\begin{array}{ll}\text{SPR} & \boxed{B}\\ \text{COMPS} & \boxed{C}\end{array}\right]\end{array}\right]\\ \text{SEM} & \boxed{2}\\ \text{ARG-ST} & \boxed{B} \oplus \boxed{C}\end{array}\right]\right\rangle\end{array}\right]$$

© 2003 CSLI Publications

cats: The (family of) Lexical Sequence(s)

$$\left\langle \text{cats} , \left[\begin{array}{ll} \textit{word} & \\ \text{SYN} & \left[\begin{array}{ll} \text{HEAD} & \left[\begin{array}{ll} \textit{noun} & \\ \text{AGR} & \textit{3pl} \end{array}\right] \\ \text{VAL} & \left[\begin{array}{ll} \text{SPR} & \boxed{\text{B}}\left\langle \left[\begin{array}{ll} & \text{DP} \\ \text{COUNT} & + \\ \text{AGR} & \boxed{7} \end{array}\right] \right\rangle \\ \text{COMPS} & \langle\,\rangle \end{array}\right] \end{array}\right] \\ \text{SEM} & \left[\begin{array}{ll} \text{MODE} & \text{ref} \\ \text{INDEX} & k \\ \text{RESTR} & \left\langle \left[\begin{array}{ll} \text{RELN} & \text{cat} \\ \text{INST} & k \end{array}\right] \right\rangle \end{array}\right] \\ \text{ARG-ST} & \boxed{\text{B}} \end{array}\right] \right\rangle$$

© 2003 CSLI Publications

Practicalities -- Writing Lexical Rules

- Determine the type of the LR.
- Determine the class of possible inputs.
- Determine what should change.
  - If INPUT and OUTPUT values are identified (by default or otherwise) and only OUTPUT value is mentioned, then...
    information is added.

    (Lexical sequences incompatible with that value are not possible inputs)
  - If INPUT and OUTPUT values are identified by default, but different values are given on the INPUT and OUTPUT of the rule, then...
    information is changed.
  - If INPUT and OUTPUT values are identified by an inviolable constraint, but different values are given on the INPUT and OUTPUT of the rule, then...
    there is no well-formed output

© 2003 CSLI Publications

Constant lexemes

- What kinds of words are constant lexemes in our grammar?
- Why do we need a rule for these words?
- What would be an alternative analysis?

© 2003 CSLI Publications

Constant Lexeme LR

$$\left[\begin{array}{ll} \textit{i-rule} & \\ \text{INPUT} & \langle\ \boxed{1}\ ,\ \textit{const-lxm}\ \rangle \\ \text{OUTPUT} & \left[\text{FIRST}\quad \boxed{1}\right] \end{array}\right]$$

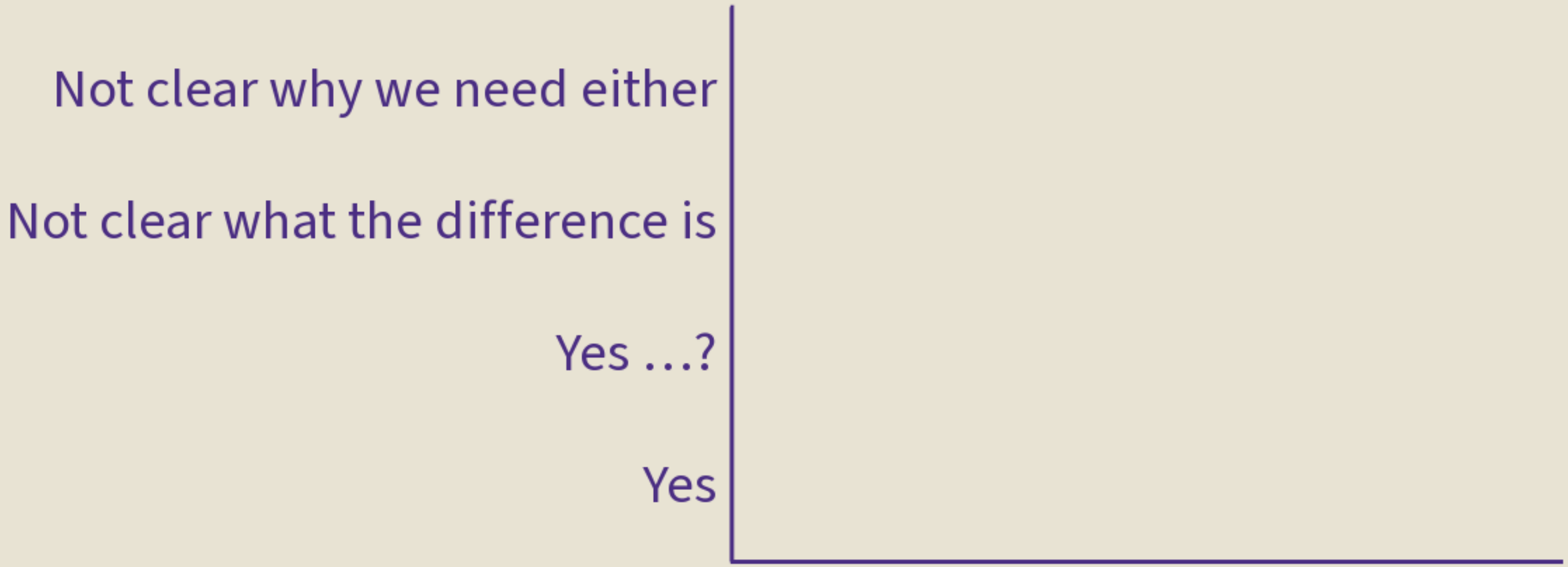
- What keeps this from applying to, say, verb lexemes?
- Why is this an *i-rule*?

© 2003 CSLI Publications

When poll is active, respond at **pollev.com/emb**

Text **EMB** to **22333** once to join

Is it clear what type of regularities are captured by lexical types and lexical rules? (take 4)



Start the presentation to see live content. For screen share software, share the entire screen. Get help at **pollev.com/app**

ARG-ST & ARP

- Given the ARP, what do we need to specify about the valence properties of words?
- Why isn't the ARP a constraint on the type *lexeme*?

© 2003 CSLI Publications

The Feature FORM

- Different inflected forms of verbs show up in different syntactic environments. Examples?
- These different forms are syntactically distinguished by the feature FORM, as assigned by lexical rules.
- FORM is also useful in our analyses of coordination and PP selection.

© 2003 CSLI Publications

How do we rule these out?

- *Kim eat pizza.
- *Kim seems to eats pizza.
- *Dana helped Leslie [pack and moved].
- *Kim relies for Sandy.
- *Dana walked and Kim.

© 2003 CSLI Publications

Overview

- How lexical rules fit in
- Three types of lexical rules, constraints
- Example: Plural noun lexical rule
- Advice on writing lexical rules
- Constant lexemes
- ARG-ST & ARP
- The feature FORM
- Reading Questions

© 2003 CSLI Publications

Reading Questions

- lexeme
- lexical entry
- lexical rule
- lexical rule instantiation
- lexical sequence
- word structure

© 2003 CSLI Publications

Reading Questions

- From 8.6: “There are a number of advantages to be derived from modeling lexical rules in this way. For example, they can be organized into a type hierarchy, with common properties factored into constraints on common supertypes.” It is unclear to me why this isn't possible with the grammar that was being developed prior to chapter 8. I would also like to go over the INPUT and OUTPUT format more.

© 2003 CSLI Publications

Reading Questions

- Why are the grammar rules not formulated as feature structures like lexical rules? How we've formulated lexical rules seems like a useful construction for other parts of the grammar, so I'm surprised we haven't used it for other rules. Is it because there are fewer generalizations we can make in the grammar rules?

© 2003 CSLI Publications

Reading Questions

- p.250: "Although it is intuitive, as well as traditional, to think of a lexical rule as a process that takes lexemes (or words) as input and gives distinct lexical entities as output, it is not necessary to introduce a new kind of device to capture the essential insights of lexical rules. In fact, lexical rules can be modeled as feature structures of a special type, which we'll call lexical-rule (l-rule). Feature structures of this type specify values for the features INPUT and OUTPUT." I'm not sure I really understand the difference between the traditional way to think of a lexical rule and the alternative feature structure model. Since the feature structure has an input and output feature, is it not basically a structure that represents a process?

© 2003 CSLI Publications

Reading Questions

- On page 251 when revisiting lexical rules the book excitedly states that we can now "use defeasible identity constraints on the values of the features INPUT and OUTPUT". I am a little concerned that I do not share the excitement of the significance of this new ability; why is this significant?

© 2003 CSLI Publications

Reading Questions

- I'm wondering what the reason is behind the defeasible SYN identity between the second elements of the INPUT and OUTPUT values of the d-rule. It seems to me that SYN is more likely to change than to stay the same when a lexeme undergoes a derivation. For example, in the derivation of cntn-lxm "driver" via the Agent Nominalization Lexical Rule (a subtype of the d-rule), HEAD, VAL, and ARG-ST all undergo heavy changes.

© 2003 CSLI Publications

Reading Questions

- In (76) Agent Nominalization d-rule, what is the benefit of having this rule? There is nothing shared in common by input and output besides index.

© 2003 CSLI Publications

Reading Questions

- In the lexical sequences shown for "dog" and "dogs" produced by the i-rule, I'm having trouble tracing where the empty COMPS lists come from.

© 2003 CSLI Publications

Reading Questions

- What do the morphological functions (FPAST, FPRP, FPSP , etc.) look like? How are they going to address verbs with irregular forms?

© 2003 CSLI Publications

Reading Questions

- I want to get some better justification for why FORM must be included in Coordination rule. It is a feature that is to be used only for verbs, and just to adjust to the Coordination rule we are giving it values for all POS?
- How do we handle the fact that for most verbs, the base form and the non-3sing present tense form are the same?

© 2003 CSLI Publications

Reading Questions

- I'm curious about why we wouldn't be able to make tense either a Head feature or a Form feature within this system, especially since we already have Form values for the past participle (psp) and present participle (prp), which when paired with the correct auxiliary can indicate tense.

© 2003 CSLI Publications

Reading Questions

- Why is tense difficult to accommodate in our current version of the grammar?
- Why don't we have separate FORM of present tense and past tense? How do we distinguish tenses then? Do we have a TENSE feature?

© 2003 CSLI Publications

Reading Questions

- In page 251, it said that the SEM values of the lexical rule's input and output are identical. I understand that as far as what we have inside of SEM, the lexical rule would not change features inside of it, but if we think of the function of lexical rule, for example 'eat' --> 'ate', are we kind of changing/limiting the semantic meaning here (from tense)?

© 2003 CSLI Publications