Ling 566
Oct 31, 2017

Lexical Rules

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

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*, ...

Parsimony & Plausibility

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

Three Kinds of Lexical Rules

- Inflectional: *lexeme* to *word*

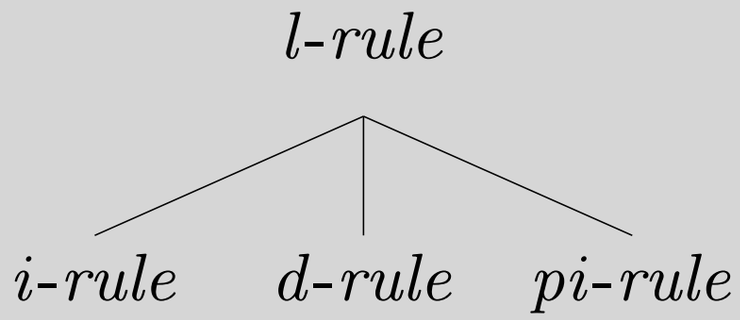
Examples?

- Derivational: *lexeme* to *lexeme*

Examples?

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

Three Subtypes of *l-rule*



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

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

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

Plural Noun LR

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

Plural Noun LR with Inherited Constraints

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

Plural Noun LR with Inherited Constraints

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

Plural Noun LR with Inherited Constraints

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

Plural Noun LR with Inherited Constraints

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

Plural Noun LR with Inherited Constraints

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

Plural Noun LR with Inherited Constraints

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

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.

Example: Lexical Entry for *cat*

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

Example: *cat*, with inheritance

$$\left\langle \text{cat} , \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{cntn-lxm}} \\ \text{SYN} & \left[\begin{array}{ll} \text{VAL} & \left[\begin{array}{l} \\ \\ \end{array} \right] \end{array} \right] \\ \text{SEM} & \left[\begin{array}{ll} \text{INDEX} & k \\ \text{RESTR} & \left\langle \left[\begin{array}{ll} \text{RELN} & \text{cat} \\ \text{INST} & k \end{array} \right] \right\rangle \end{array} \right] \end{array} \right] \right\rangle$$

Example: *cat*, with inheritance

$$\left\langle \text{cat} , \left[\begin{array}{l} \textit{cntn-lxm} \\ \text{SYN} \quad \left[\begin{array}{l} \text{VAL} \quad \left[\begin{array}{l} \text{SPR} \quad \left\langle \left[\text{COUNT} \quad + \right] \right\rangle \\ \\ \\ \end{array} \right] \\ \\ \\ \end{array} \right] \\ \text{SEM} \quad \left[\begin{array}{l} \text{INDEX} \quad k \\ \\ \text{RESTR} \quad \left\langle \left[\begin{array}{ll} \text{RELN} & \text{cat} \\ \text{INST} & k \end{array} \right] \right\rangle \end{array} \right] \end{array} \right] \right\rangle$$

Example: *cat*, with inheritance

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

Example: *cat*, with inheritance

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

Plural Noun LR

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

Licensing *cats*

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

cats: The Lexical Sequence

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

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

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?

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*?

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*?

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.

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.

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- Three types of lexical rules, constraints
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- Advice on writing lexical rules
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- The feature FORM
- Reading Questions

Reading Questions

- What's the difference or relationship between a lexical entry and a lexical sequence? What's the difference between a lexical entry and a lexeme?
- How does the fact that defeasible constraints that are not overridden become inviolable work with the 'speed of math' 'order independent' grammar formalism?
- Is there a way to reconcile the notion that, even though we have "inputs" and "outputs", and some transformation is being applied, that the lexical rules are not "temporal"? Early on in the class you encouraged us to not think of the grammar as being temporal (e.g. bottom-up or top-down) but as just a state of being; I'm not sure how/if that works with the lexical rules.

Reading Questions

- In (62), the [3] tag is used between the SYN values of the input and output. In the past, you've said that these relations happen "at the speed of math" - so doesn't this indicate that the input and output are the same? My assumption is that in this case, the [3] in the input is the initial value for the feature, and the additions in the output are how it is changed. Why, then, is PER specified in the output? If I understand this correctly, the PER value will comes from the cn-lxm type, which should be part of the input.

Reading Questions

(61) Singular Noun Lexical Rule

$$\left[\begin{array}{l} \textit{i-rule} \\ \text{INPUT} \quad \left\langle \boxed{1}, \textit{cn-lxm} \right\rangle \\ \text{OUTPUT} \quad \left\langle \boxed{1}, \left[\text{SYN} \quad \left[\text{HEAD} \quad \left[\text{AGR} \quad \left[\text{NUM sg}\right]\right]\right]\right]\right\rangle \end{array}\right]$$

Reading Questions

(62) Singular Noun Lexical Rule (with inherited constraints)

$$\left[\begin{array}{l} \textit{i-rule} \\ \text{INPUT} \quad \left\langle \boxed{1}, \left[\begin{array}{ll} \textit{cn-lxm} & \\ \text{SYN} & \boxed{3} \\ \text{SEM} & \boxed{2} \\ \text{ARG-ST} & \boxed{A} \end{array}\right] \right\rangle \\ \text{OUTPUT} \quad \left\langle \boxed{1}, \left[\begin{array}{ll} \textit{word} & \\ \text{SYN} & \boxed{3}\left[\text{HEAD} \left[\text{AGR} \left[\begin{array}{ll} \text{PER} & \text{3rd} \\ \text{NUM} & \text{sg} \end{array}\right]\right]\right] \\ \text{SEM} & \boxed{2} \\ \text{ARG-ST} & \boxed{A} \end{array}\right] \right\rangle \end{array}\right]$$

Reading Questions

- Why is the lexical sequence (74) an invalid resolution of the form (32) on page 239?

(74) A lexical sequence that doesn't give rise to any words

$$\left\langle \text{dog} , \left[\begin{array}{ll} \textit{cntn-lxm} & \\ \text{SYN} & \left[\begin{array}{ll} \text{HEAD} & \left[\begin{array}{ll} \textit{noun} & \\ \text{AGR} & \boxed{1}\left[\text{PER 3rd}\right] \end{array} \right] \\ \text{VAL} & \left[\begin{array}{ll} \text{SPR} & \langle\, \text{NP}[\text{AGR } \boxed{1}]\, \rangle \\ \text{COMPS} & \langle\, \text{NP, NP, VP, NP}\, \rangle \end{array} \right] \end{array} \right] \\ \text{SEM} & \left[\begin{array}{ll} \text{MODE} & \text{ref} \\ \text{INDEX} & i \\ \text{RESTR} & \left\langle \left[\begin{array}{ll} \text{RELN} & \textbf{dog} \\ \text{INST} & i \end{array} \right] \right\rangle \end{array} \right] \\ \text{ARG-ST} & \langle\, \left[\begin{array}{c} \text{DP} \\ \text{COUNT } + \end{array} \right] \rangle \end{array} \right] \right\rangle$$

Reading Questions

- How does *dog* end up with an empty COMPS list? None of its supertypes seem to constrain COMPS at all.

Reading Questions

- The chapter says all *pos* now have FORM values, but how would that look (and why would it be important beyond the Coordination Rule) on *const-lxm* words that would only have one form?

Reading Questions

- What does "only finite Ss can be stand-alone utterances" mean?
- If only [FORM fin] S can be stand-alone, why do we see sentences with verb in so many different FORM values?
- Are these Ss no longer considered stand-alone/ independent utterances?
  - Andy is eating rice (prp)
  - Andy has eaten rice(psp)
  - Rice was eaten by Andy (pass)

Reading Questions

- Why and how can we use the FORM identity condition to impose the requirement that conjunct daughters must have the same part of speech without identifying their HEAD values? Isn't it redundant to have both HEAD noun and FORM nform?
- What's the difference between the use of FORM feature and subtypes of lexeme?

Reading Questions

- How does the design and structure of lexical rules play into machine translation? Do languages with similar rules translate more easily?
- Do these rules do some of the work involved with affix ordering? In the case of *computering* it seems like, together with the hand wavy morphological functions, they might.