A Recall from last lecture

We want grammars that allow us to assign “good” structures to “good sentences”:

... but don’t allow us to assign structures to “bad sentences”, like “* they puts baskets from sleep”.

Many required *lexically-induced* features ⇒ proliferation of sub-types:

\[
\begin{aligned}
V_{\text{subject:animateNP,1:puttableNP,2:locationPP}} & \rightarrow \\
V_{\text{subject:animateNP,1:puttableNP,2:locationPP,3:NP}} & \text{puttable,directobjectformPPlocation}
\end{aligned}
\]

B Developing CFG parsing intuitions

1. Start symbol is S; decompositions \( \mathcal{R} \) is the following set\(^1\) (using “tree notation” rather than “rule notation” \( S \rightarrow R \)), which we’ll consider to induce: Terminals \( T = \{\text{no}\} \); nonterminals \( N = \{S, L, R\} \).

*Question*: how many parse trees does this CFG assign to “no no no”? 

\[
\begin{align*}
1 & \\
\alpha_1 & : S \quad \alpha_2 : S \\
\alpha_3 & : R \quad \alpha_4 : L \\
\alpha_5 & : L \quad \alpha_6 : R
\end{align*}
\]

\(^1\)Tree layout using the QobiTree package.
2. **Question:** how many parse trees does the (induced) CFG below assign to “no no no”?

\[ \begin{array}{c}
\alpha_7: \quad S \\
| \no \\
\alpha_8: \quad S \Rightarrow no \\
\alpha_9: \quad no \Rightarrow S
\end{array} \]

3. A CFG worth knowing about. “ε” is the empty string.

\[ \begin{array}{c}
\alpha_{10}: \quad S \\
| \no \\
\alpha_{11}: \quad S \\
| \epsilon \\
\alpha_{12}: \quad S \Rightarrow S
\end{array} \]

How many parses for “no no no”?

Is the set of sentences it assigns structures to the same as in the previous CFG?

C Back to the “category proliferation problem” from last time (“let’s be clever engineers”)

From the grammar-designer’s perspective, we’d like:

4. $VP \rightarrow V \ NP \ PrepP$
   
   - $VP$ agreement $\sqcap V$ agreement
   - $V$’s first argument constraints $\sqcap NP$
   - $V$’s second argument constraints $\sqcap PrepP$

where $\sqcap$ means “unify” (“smallest set of constraints consistent with both operands’ constraint sets”).
Handling gaps in question inversion (another type of long-distance dependencies)

5. what do the cashiers put in the boxes?
6. where do the cashiers put the boxes?
7. * the cashiers put boxes
8. * what do the cashiers put the boxes
9. $S_{\text{question}} \rightarrow \text{NP-WH AUX NP VP}$
   - NP-WH $\sqcap$ VP direct object
   - VP’s direct object must have gap: +
   - Subject NP must have gap: −
   - … (other agreement constraints)

Add to 4:
- at most one of NP, PrepP can have gap: −

10. $\text{NP} \rightarrow \varepsilon$
   - NP gap $\sqcap$ yes

E Tree substitution grammars: extend the domain of locality