Chapter 4: Sections 4.1-4.5:

Valence

Reminder: Where We Are

- Attempting to model English with CFG led to problems with the granularity of categories, e.g.
  - Need to distinguish various subtypes of verbs
  - Need to identify properties common to all verbs
- So we broke categories down into feature structures and began constructing a hierarchy of types of feature structures.
- This allows us to schematize rules and state cross-categorial generalizations, while still making fine distinctions

But it's still not quite right…

- There's still too much redundancy in the rules.
- The rules and features encode the same information in different ways.

Head-Complement Rule 1:

$$\begin{bmatrix} \textit{phrase} \\ \text{VAL} \quad \begin{bmatrix} \text{COMPS} & \text{itr} \\ \text{SPR} & - \end{bmatrix} \end{bmatrix} \rightarrow \mathbf{H} \begin{bmatrix} \textit{word} \\ \text{VAL} \quad \begin{bmatrix} \text{COMPS} & \text{itr} \\ \text{SPR} & - \end{bmatrix} \end{bmatrix}$$

Head Complement Rule 2:

$$\begin{bmatrix} \textit{phrase} \\ \text{VAL} \quad \begin{bmatrix} \text{COMPS} & \text{itr} \\ \text{SPR} & - \end{bmatrix} \end{bmatrix} \rightarrow \mathbf{H} \begin{bmatrix} \textit{word} \\ \text{VAL} \quad \begin{bmatrix} \text{COMPS} & \text{str} \\ \text{SPR} & - \end{bmatrix} \end{bmatrix} \text{ NP}$$

Head Complement Rule 3:

$$\begin{bmatrix} \textit{phrase} \\ \text{VAL} \quad \begin{bmatrix} \text{COMPS} & \text{itr} \\ \text{SPR} & - \end{bmatrix} \end{bmatrix} \rightarrow \mathbf{H} \begin{bmatrix} \textit{word} \\ \text{VAL} \quad \begin{bmatrix} \text{COMPS} & \text{dtr} \\ \text{SPR} & - \end{bmatrix} \end{bmatrix} \text{ NP NP}$$

Solution:
More Elaborate Valence Feature Values

- The rules just say that heads combine with whatever their lexical entries say they can (or must) combine with.
- The information about what a word can or must combine with is encoded in list-valued valence features.
  - The elements of the lists are themselves feature structures
  - The elements are "cancelled" off the lists once heads combine with their complements and specifiers.

Complements

Head-Complement Rule:

$$\begin{bmatrix} phrase \\ \text{VAL} \quad \begin{bmatrix} \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \rightarrow \mathbf{H} \begin{bmatrix} word \\ \text{VAL} \quad \begin{bmatrix} \text{COMPS} & \langle \boxed{1}, \ldots, \boxed{n} \rangle \end{bmatrix} \end{bmatrix} \boxed{1}, \ldots, \boxed{n}$$

- This allows for arbitrary numbers of complements, but only applies when there is at least one.
  - Heads in English probably never have more than 3 or 4 complements
  - This doesn't apply where Head-Complement Rule 1 would. (Why?)
- This covers lots of cases not covered by the old Head-Complement Rules 1-3. (Examples?)

Question: How would the grammar change if English had **post**positions, instead of **pre**positions?

Head-Complement Rule

$$\begin{bmatrix} \textit{phrase} \\ \text{VAL} \quad \begin{bmatrix} \text{COMPS} \quad \langle\ \rangle \end{bmatrix} \end{bmatrix} \rightarrow \mathbf{H} \begin{bmatrix} \textit{word} \\ \text{HEAD} \quad \textit{verb} \mid \textit{adj} \mid \textit{noun} \\ \text{VAL} \quad \begin{bmatrix} \text{COMPS} \quad \langle \boxed{1}, \ldots, \boxed{n} \rangle \end{bmatrix} \end{bmatrix} \boxed{1}, \ldots, \boxed{n}$$

PP Rule

$$\begin{bmatrix} \textit{phrase} \\ \text{VAL} \quad \begin{bmatrix} \text{COMPS} \quad \langle\ \rangle \end{bmatrix} \end{bmatrix} \rightarrow \boxed{1}, \ldots, \boxed{n} \quad \mathbf{H} \begin{bmatrix} \textit{word} \\ \text{HEAD} \quad \textit{prep} \\ \text{VAL} \quad \begin{bmatrix} \text{COMPS} \quad \langle \boxed{1}, \ldots, \boxed{n} \rangle \end{bmatrix} \end{bmatrix}$$

Specifiers

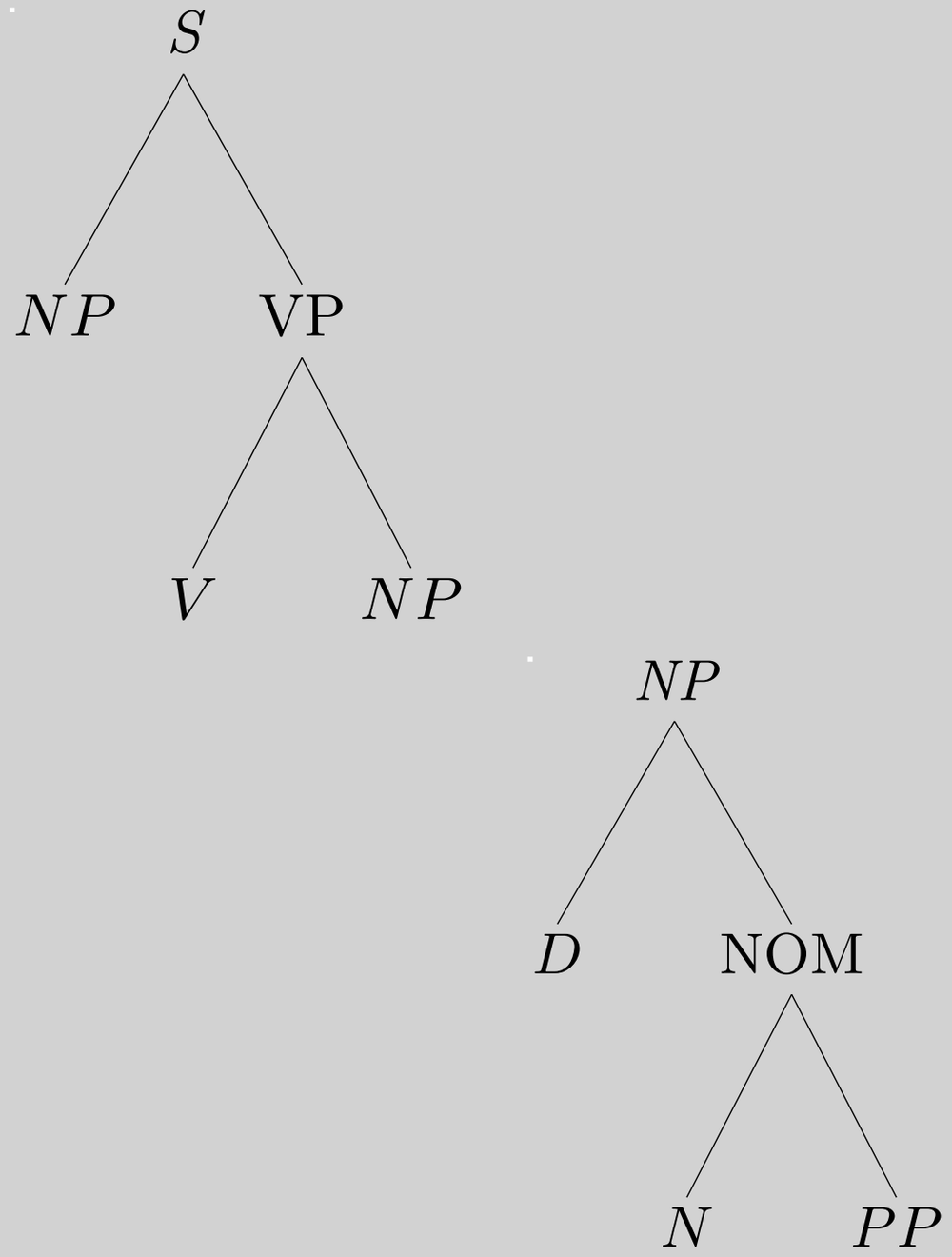
Head-Specifier Rule (Version I)

$$\begin{bmatrix} phrase \\ \text{VAL} \quad \begin{bmatrix} \text{COMPS} & \langle\ \rangle \\ \text{SPR} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \rightarrow \boxed{2} \quad \mathbf{H}\begin{bmatrix} \text{VAL} \quad \begin{bmatrix} \text{COMPS} & \langle\ \rangle \\ \text{SPR} & \langle\ \boxed{2}\ \rangle \end{bmatrix} \end{bmatrix}$$

- Combines the rules expanding S and NP.
- In principle also generalizes to other categories.
- Question: Why is SPR list-valued?

Question:

Why are these right-branching? That is, what formal property of our grammar forces the COMPS to be lower in the tree than the SPR?



Another Question…

What determines the VAL value of phrasal nodes?

ANSWER: The Valence Principle

Unless the rule says otherwise, the mother's values for the VAL features (SPR and COMPS) are identical to those of the head daughter.

More on the Valence Principle

- Intuitively, the VAL features list the contextual requirements that haven't yet been found.
- This way of thinking about it (like talk of "cancellation") is bottom-up and procedural.
- But formally, the Valence Principle (like most of the rest of our grammar) is just a well-formedness constraint on trees, without inherent directionality.

Mathematical Afterthoughts

- As noted earlier, some languages have constructions provably beyond the descriptive power of CFG
- Analyzing CFG categories into feature structures does not increase the mathematical power of the system, so long as there are still only finitely many categories.

Complex Feature Values and CFG Equivalence

- With feature structures in the values of other features, however, we now have the possibility of recursion in feature structures.
- E. g. [COMPS <[COMPS <[COMPS…] >] >]
- This allows for infinite sets of categories, which allows for the description of languages that are not context-free.

Feature Structure Recursion is Limited

- Descriptive linguists using feature structure grammars have not used more than one level of recursion in feature structures.
- A formal restriction along these lines would bring us back to CFG equivalence.
- But the equivalent CFG would have a huge number of categories.