Class Notes: Modifiers and Recursion (06/22)

We looked at three kinds of modifier in class: NP modifiers, VP modifiers and adjectives (which are noun modifiers). Here are some examples:

**NP modifiers:**

The man met Bill  ⇒  The man with the telescope met Bill  
(modifies the NP “the man”)

John saw the girl  ⇒  John saw the girl with the glasses  
(modifies the NP “the girl”)

**VP modifiers:**

The man met Bill  ⇒  The man met Bill in his house  
(modifies the action described by the VP “met Bill.”)

The boy kissed the girl  ⇒  The boy kissed the girl on the train  
(modifies the action described by the VP the girl.”)

**Adjectives (noun modifiers):**

The boy kissed the girl  ⇒  The shy boy kissed the girl  
(modifies the noun “boy”)

In all these cases, the modifier is pretty simple – either a single word or a simple PP. We will only look at simple modifiers in this class, although modifiers can get much more complicated than this. For example, the italicized phrase in the following sentence is a VP modifier:

The boy bought the book after he read the first few pages.

We could deal with complex modifiers like this by adding more phrase structure rules, but we won’t actually get around to doing this.

At the beginning of class, we were working with a system of phrase structure rules like this:

- S  →  NP VP
- NP  →  (Det) (Adj) N (PP)
- VP  →  V (NP) (PP)
- PP  →  P NP

The obvious problem with these rules is that they only allow for one modifier to attach to any given phrase. For example, the NP rule allows an NP to have a single PP modifier (as in “A book about Obama”) but no more (we can’t generate “A book about Obama by John.”) Our first try at a solution to this problem was simply to
modify the rules to say that any number of modifiers were permitted. To do this, we used the * symbol, named the Kleene star after Stephen Kleene (http://en.wikipedia.org/wiki/Stephen_Cole_Kleene). The NP and VP rules were modified to look like this:

\[
\begin{align*}
\text{NP} & \rightarrow (\text{Det}) \text{ Adj}* \text{ N PP*} \\
\text{VP} & \rightarrow \text{ V (NP) PP*}
\end{align*}
\]

Using the * works well for adjectival modifiers, so we’ll have nothing more to say about them. However, there’s a serious problem with using the Kleene star for NP and VP modifiers: it gets the constituent structure wrong. For example, using these rules, we get the following tree for the following sentence:

John bought a book for Bill on Tuesday

According to this tree, although the string “bought a book for Bill on Tuesday” is a constituent, the strings “bought a book” and “bought a book for Bill” are not constituents. We can show that they are in fact constituents using the pro-form substitution constituency test:

John bought a book for Bill on Tuesday
...and Bill did on Wednesday
“Did” means “bought a book for Bill”, so this string must be a constituent.

John bought a book for Bill on Tuesday
...and Mary did for Jane on Wednesday
“Did” can mean “bought a book”, so this string must be a constituent.
We could use a similar method to show that the rule for introducing NP modifiers is also getting the constituent structure wrong, but I'll ask you to take my word for it for now.

The correct rules for introducing VP and NP modifiers are as follows:

\[
\begin{align*}
\text{NP} & \rightarrow \text{NP PP} \\
\text{VP} & \rightarrow \text{VP PP}
\end{align*}
\]

These say “give me an NP, and I'll give you back a bigger NP with a PP modifier added” (and “give me a VP, and I'll give you back a bigger VP with a PP modifier added.”) These rules allow for recursion: we can have VPs within VPs within VPs within VPs... (and the same for NPs within NPs). With these new rules added, our complete set of phrase structure rules is as follows:

\[
\begin{align*}
\text{S} & \rightarrow \text{NP VP} \\
\text{NP} & \rightarrow (\text{Det}) \text{ Adj* N} \\
\text{NP} & \rightarrow \text{NP PP} \\
\text{VP} & \rightarrow \text{V (NP)} \quad \text{Note: we've gotten rid of the (PP) here.} \\
\text{VP} & \rightarrow \text{VP PP} \\
\text{PP} & \rightarrow \text{P NP}
\end{align*}
\]

(Remember, we're still using the Kleene star for adjectival modifiers.)

Here are examples of VP and NP modification using these rules:

**VP modification:**

![Diagram of VP modification]
NP modification:

Because we've added recursive NP and VP rules, we can easily generate sentences with multiple VP or NP modifiers. For example, here is a sentence with three VP modifiers:
We find other examples of recursion in language. For example, while most verbs take NPs as objects, some verbs take an entire sentence as their object. The verb *think* is one of these:

![Diagram of a sentence structure](image)

We need to modify one of our VP rules to allow for verbs to take sentences as objects:

\[
VP \rightarrow V \text{(NP)} \text{(S)}
\]

Note that as predicted by this rule, some verbs can take *both* a noun and a sentence as objects:
As before, we can have as many sentences within sentences as we like (just as we can have as many PP modifiers as we like):
We will look at this kind of recursion in more detail on Tuesday/Wednesday.