Syntax:
Recursion, Conjunction, and Constituency
Supplementary Readings

The following readings have been posted to the Moodle course site:

- Language Files: Chapter 5 (pp. 204-215, 216-220)
- Language Instinct: Chapter 4 (pp. 74-99)
An Interesting Property of our PS Rules

Our Current PS Rules:

\[
S \rightarrow \{ \text{NP, CP} \} \text{ VP}
\]
\[
\text{NP} \rightarrow (D) (A^*) N (\text{CP}) (\text{PP}^*)
\]
\[
\text{VP} \rightarrow V (\text{NP}) \{ (\text{NP}) (\text{CP}) \} (\text{PP}^*)
\]
\[
\text{PP} \rightarrow P (\text{NP})
\]
\[
\text{CP} \rightarrow C S
\]

An Interesting Feature of These Rules:

As we saw last time, these rules allow **sentences** to contain other **sentences**.

- A sentence must have a VP in it.
- A VP can have a CP in it.
- A CP must have an S in it.
An Interesting Property of our PS Rules

Our Current PS Rules:

\[
\begin{align*}
S & \rightarrow \{ \text{NP, CP} \} \text{ VP} \\
\text{NP} & \rightarrow (D) (A^*) \text{ N} (\text{CP}) (\text{PP}^*) \\
\text{VP} & \rightarrow V (\text{NP}) \{ (\text{NP}) (\text{CP}) \} (\text{PP}^*) \\
\text{PP} & \rightarrow P (\text{NP}) \\
\text{CP} & \rightarrow C \ S
\end{align*}
\]

An Interesting Feature of These Rules:
As we saw last time, these rules allow sentences to contain other sentences.

Dave thinks that he is cool
An Interesting Property of our PS Rules

Our Current PS Rules:

\[
S \rightarrow \{ \text{NP} , \text{CP} \} \text{ VP} \\
\text{NP} \rightarrow (\text{D}) (\text{A}^*) \text{ N (CP) (PP*)} \\
\text{VP} \rightarrow \text{V (NP) } \{ (\text{NP}) (\text{CP}) \} (\text{PP*}) \\
\text{PP} \rightarrow \text{P (NP)} \\
\text{CP} \rightarrow \text{C S}
\]

Another Interesting Feature of These Rules:
These rules also allow **noun phrases** to contain other **noun phrases**.

- An NP can contain an (optional) PP.
- A PP can contain an (optional) NP.
An Interesting Property of our PS Rules

Our Current PS Rules:

S $\rightarrow$ \{ NP, CP \} VP

NP $\rightarrow$ (D) (A*) N (CP) (PP*)

VP $\rightarrow$ V (NP) \{ (NP) (CP) \} (PP*)

PP $\rightarrow$ P (NP)

CP $\rightarrow$ C S

Another Interesting Feature of These Rules:

These rules also allow noun phrases to contain other noun phrases.

```
NP
  ___________
   |         |
  D       N   PP
    |     |     |
  the   man  P
            |     |
          with   NP
                |
                      a telescope
```
Recursion

Our Current PS Rules:

\[
\begin{align*}
S & \rightarrow \{ \text{NP} , \text{CP} \} \text{ VP} \\
\text{NP} & \rightarrow (\text{D}) (\text{A}^*) \text{ N} (\text{CP}) (\text{PP}^*) \\
\text{VP} & \rightarrow \text{V} (\text{NP}) \{ (\text{NP}) (\text{CP}) \} (\text{PP}^*) \\
\text{PP} & \rightarrow \text{P} (\text{NP}) \\
\text{CP} & \rightarrow \text{C} \text{ S}
\end{align*}
\]

Vocabulary:

**Recursion** is when an expression of some type contains another expression *of that same type*
Recursion

Our Current PS Rules:

\[
S \rightarrow \{ \text{NP} , \text{CP} \} \ \text{VP} \\
\text{NP} \rightarrow (\text{D}) (\text{A}^*) \text{ N} (\text{CP}) (\text{PP}^*) \\
\text{VP} \rightarrow \text{V} (\text{NP}) \{ (\text{NP}) (\text{CP}) \} (\text{PP}^*) \\
\text{PP} \rightarrow \text{P} (\text{NP}) \\
\text{CP} \rightarrow \text{C} \ S
\]

Vocabulary:

**Recursion** is when an expression of some type contains another expression *of that same type*

- Sentences containing other sentences
  - Dave thinks that **he is cool**
  - Dave wonders if **he is cool**
  - That **he is not cool** surprises Dave.
Recursion

Our Current PS Rules:

S → { NP , CP } VP
NP → (D) (A*) N (CP) (PP*)
VP → V (NP) { (NP) (CP) } (PP*)
PP → P (NP)
CP → C S

Vocabulary:

Recursion is when an expression of some type contains another expression of that same type

- Sentences containing other sentences
  - Dave thinks that he is cool
  - Dave wonders if he is cool
  - That he is not cool surprises Dave.

- Noun Phrases (NPs) containing other NPs
  - The man with a telescope
  - The rock near the tree
  - Some dogs outside this house
The Consequences of Recursion

Question:
So what? What’s so neat about ‘recursion’?
The Consequences of Recursion

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Answer, Part 1:
Once recursion gets started, *it never has to stop.*
The Consequences of Recursion

Question:
So what? What’s so neat about ‘recursion’?

Answer, Part 1:
Once recursion gets started, it never has to stop.

- Once the rules allow a sentence inside a sentence...
  (Dave thinks that he is cool)
The Consequences of Recursion

Question:  
So what? What’s so neat about ‘recursion’?

Answer, Part 1:  
Once recursion gets started, *it never has to stop.*

- Once the rules allow a sentence inside a sentence...  
  (Dave thinks that he is cool)

- ...then they also allow a sentence in a sentence in a sentence...  
  (Mary said that Dave thinks that he is cool)
The Consequences of Recursion

Question:
So what? What’s so neat about ‘recursion’?

Answer, Part 1:
Once recursion gets started, *it never has to stop*.

- Once the rules allow a sentence inside a sentence...
  (Dave thinks that he is cool)

- ...then they also allow a sentence in a sentence in a sentence...
  (Mary said that Dave thinks that he is cool)

- ...and a sentence in a sentence in a sentence in a sentence...
  (John wonders if Mary said that Dave thinks that he is cool)
The Consequences of Recursion

Question:
So what? What’s so neat about ‘recursion’?

Answer, Part 1:
Once recursion gets started, *it never has to stop*.

- Once the rules allow a sentence inside a sentence...
  (Dave thinks that he is cool)

- ...then they also allow a sentence in a sentence in a sentence...
  (Mary said that Dave thinks that he is cool)

- ...and a sentence in a sentence in a sentence in a sentence...
  (John wonders if Mary said that Dave thinks that he is cool)

- ...and so on, and so on....
The Consequences of Recursion

Question: 
*But what’s so great about that?*

Answer, Part 1: 
Once recursion gets started, *it never has to stop.*

- Once the rules allow a sentence inside a sentence...
  (Dave thinks that *he is cool*)

- ...then they also allow a sentence in a sentence in a sentence...
  (Mary said that *Dave thinks that he is cool*)

- ...and a sentence in a sentence in a sentence in a sentence...
  (John wonders if *Mary said that Dave thinks that he is cool*)

- ...and so on, and so on....
The Consequences of Recursion

Question: *But what’s so great about that?*

Answer, Part 2: Thanks to this, there are literally an *infinite* number of possible English sentences.
The Consequences of Recursion

**Question:**

But what's so great about that?

**Answer, Part 2:**

Thanks to this, there are literally an *infinite* number of possible English sentences.

- After all, suppose there were only *finitely* many possible English sentences.
The Consequences of Recursion

Question:  
*But what’s so great about that?*

Answer, Part 2:  
Thanks to this, there are literally an *infinite* number of possible English sentences.

- After all, suppose there were only *finitely* many possible English sentences.
- Then, there’d necessarily be a longest English sentence, $S$. 
The Consequences of Recursion

Question: 
*But what’s so great about that?*

Answer, Part 2: 
Thanks to this, there are literally an *infinite* number of possible English sentences.

- After all, suppose there were only *finitely* many possible English sentences.
- Then, there’d necessarily be a longest English sentence, $S$.
- But, we could always make a *longer* sentence by embedding $S$: (Dave thinks that $S$)
The Consequences of Recursion

Question:
*But what’s so great about that?*

Answer, Part 2:
Thanks to this, there are literally an *infinite* number of possible English sentences.

- After all, suppose there were only *finitely* many possible English sentences.
- Then, there’d necessarily be a longest English sentence, $S$.
- But, we could always make a *longer* sentence by embedding $S$: (Dave thinks that $S$)
- Therefore, there is no ‘longest possible’ English sentence (Just like there is no ‘biggest number’)

*After all, suppose there were only finitely many possible English sentences.*
The Consequences of Recursion

Question:  
*But what’s so great about that?*

Answer, Part 2:  
Thanks to this, there are literally an *infinite* number of possible English sentences.

- After all, suppose there were only *finitely* many possible English sentences.
- Then, there’d necessarily be a longest English sentence, $S$.
- But, we could always make a *longer* sentence by embedding $S$: (Dave thinks that $S$)
- Therefore, there is no ‘longest possible’ English sentence (Just like there is no ‘biggest number’)
- Therefore, the number of possible English sentences is *infinite*!
The Consequences of Recursion

The Main Importance of Recursion: Recursion seems to make human language fundamentally different from other kinds of animal communication.

- Other organisms have complex ‘languages’ (bees, dolphins)
- But none of them have been found to exhibit recursion (so far)
- So recursion may be part of what makes human language so special...
Conjunction of Noun Phrases

Our Current PS Rules:

S → \{ NP, CP \} VP
NP → (D) (A*) N (CP) (PP*)
VP → V (NP) \{ (NP) (CP) \} (PP*)
PP → P (NP)
CP → C S

Problem:
Our rules won’t let us make sentences like the following:

- Bill and Dave danced.
- The dog chased the young cat and the ugly boy.
- Dave walked past the school and the church.
Conjunction of Noun Phrases

Our Current PS Rules:

\[ S \rightarrow \{ \text{NP}, \text{CP} \} \ \text{VP} \]
\[ \text{NP} \rightarrow (\text{D}) (\text{A}^*) \text{ N} (\text{CP}) (\text{PP}^*) \]
\[ \text{VP} \rightarrow \text{V} (\text{NP}) \{ (\text{NP}) (\text{CP}) \} (\text{PP}^*) \]
\[ \text{PP} \rightarrow \text{P} (\text{NP}) \]
\[ \text{CP} \rightarrow \text{C} \ S \]

The Pattern:
Wherever English allows \textit{one} NP, it also allows \textit{two} NPs joined by ‘\textit{and}’.
Conjunction of Noun Phrases

Our Current PS Rules:

S → { NP , CP } VP
NP → (D) (A*) N (CP) (PP*)
VP → V (NP) { (NP) (CP) } (PP*)
PP → P (NP)
CP → C S

The Pattern:
Wherever English allows \textit{one} NP, it also allows \textit{two} NPs joined by ‘and’.

Temporary Solution:
Let’s introduce the following, additional rule for NPs:

\[ NP → NP \text{ and } NP \]

(An NP can be formed from two other NPs joined by ‘and’).
Conjunction of Noun Phrases

Our Updated PS Rules:

\[
S \rightarrow \{ \text{NP, CP} \} \text{ VP}
\]
\[
\text{NP} \rightarrow (D) (A^*) \text{ N (CP) (PP*)}
\]
\[
\text{NP} \rightarrow \text{NP and NP}
\]
\[
\text{VP} \rightarrow V (\text{NP}) \{ (\text{NP}) (\text{CP}) \} (\text{PP*})
\]
\[
\text{PP} \rightarrow P (\text{NP})
\]
\[
\text{CP} \rightarrow C S
\]

*We can now form those sentences that we couldn’t before:*
Conjunction of Noun Phrases

Our Updated PS Rules:

\[ S \rightarrow \{ NP, CP \} \ VP \]
\[ NP \rightarrow (D) (A^*) N (CP) (PP^*) \]
\[ NP \rightarrow NP \text{ and } NP \]
\[ VP \rightarrow V (NP) \{ (NP) (CP) \} (PP^*) \]
\[ PP \rightarrow P (NP) \]
\[ CP \rightarrow C S \]

Dave walked past the school and the church.
Conjunction of Verb Phrases

Our Updated PS Rules:

\[
\begin{align*}
S & \rightarrow \{ \text{NP} , \text{CP} \} \text{ VP} \\
\text{NP} & \rightarrow (D) (A^*) \text{ N (CP) (PP^*)} \\
\text{NP} & \rightarrow \text{NP and NP} \\
\text{VP} & \rightarrow \text{V (NP) } \{ \text{(NP) (CP) } \} \text{ (PP^*)} \\
\text{PP} & \rightarrow \text{P (NP)} \\
\text{CP} & \rightarrow \text{C S}
\end{align*}
\]

Problem:
These rules \textit{still} won’t let us make sentences like the following:

- Dave dances \textbf{and} smokes cigars.
- Tom walked into the house \textbf{and} sat down.
- Mary screamed \textbf{and} said her ankle hurt.
Conjunction of Verb Phrases

Our Updated PS Rules:

\[
\begin{align*}
S & \rightarrow \{ \text{NP, CP} \} \text{ VP} \\
\text{NP} & \rightarrow (D) (A^*) \text{ N} (\text{CP}) (\text{PP}^*) \\
\text{NP} & \rightarrow \text{NP and NP} \\
\text{VP} & \rightarrow \text{V} (\text{NP}) \{ (\text{NP}) (\text{CP}) \} (\text{PP}^*) \\
\text{PP} & \rightarrow \text{P} (\text{NP}) \\
\text{CP} & \rightarrow \text{C S}
\end{align*}
\]

The Pattern:
Wherever English allows *one* VP, it also allows *two* VPs joined together by ‘*and*’.
Conjunction of Verb Phrases

Our Updated PS Rules:

\[
\begin{align*}
S & \rightarrow \{ \text{NP, CP} \} \text{ VP} \\
\text{NP} & \rightarrow (D) (A^*) \text{ N (CP) (PP*)} \\
\text{NP} & \rightarrow \text{NP and NP} \\
\text{VP} & \rightarrow V (\text{NP}) \{ (\text{NP}) (\text{CP}) \} (\text{PP*}) \\
\text{PP} & \rightarrow P (\text{NP}) \\
\text{CP} & \rightarrow C S
\end{align*}
\]

The Pattern:
Wherever English allows *one* VP, it also allows *two* VPs joined together by ‘and’.

Temporary Solution:
Let’s introduce the following, additional rule for VPs:

\[
\text{VP} \rightarrow \text{VP and VP}
\]

(A VP can be formed from two other VPs joined by ‘and’).
Conjunction of Noun Phrases

Our Updated PS Rules:

\[ S \rightarrow \{ NP, CP \} \ VP \]
\[ NP \rightarrow (D) (A^*) N (CP) (PP^*) \]
\[ NP \rightarrow NP \text{ and } NP \]
\[ VP \rightarrow V (NP) \{ (NP) (CP) \} (PP^*) \]
\[ VP \rightarrow VP \text{ and } VP \]
\[ PP \rightarrow P (NP) \]
\[ CP \rightarrow C S \]

*We can now form those sentences that we couldn't before:*
Conjunction of Prepositional Phrases

Our Updated PS Rules:

\[
\begin{align*}
S & \rightarrow \{ \text{NP}, \text{CP} \} \text{ VP} \\
\text{NP} & \rightarrow (D) (A^*) \text{ N} (\text{CP}) (\text{PP}^*) \\
\text{NP} & \rightarrow \text{NP and NP} \\
\text{VP} & \rightarrow V (\text{NP}) \{ (\text{NP}) (\text{CP}) \} (\text{PP}^*) \\
\text{VP} & \rightarrow \text{VP and VP} \\
\text{PP} & \rightarrow P (\text{NP}) \\
\text{CP} & \rightarrow C S
\end{align*}
\]

Problem:
These rules *still* won’t let us make sentences like the following:

- Dave walked out the door and into the yard.
- People with guns and without licenses will be arrested.
Conjunction of Prepositional Phrases

Our Updated PS Rules:

\[
\begin{align*}
S & \rightarrow \{ \text{NP, CP} \} \text{ VP} \\
\text{NP} & \rightarrow (D) (A^*) \text{ N (CP) (PP*)} \\
\text{NP} & \rightarrow \text{NP and NP} \\
\text{VP} & \rightarrow V \ (\text{NP}) \ \{ (\text{NP}) \ (\text{CP}) \ \} \ (\text{PP*}) \\
\text{VP} & \rightarrow \text{VP and VP} \\
\text{PP} & \rightarrow P \ (\text{NP}) \\
\text{CP} & \rightarrow C \ S
\end{align*}
\]

The Pattern:
Wherever English allows *one* PP, it also allows *two* PPs joined together by ‘and’.

Temporary Solution:
Let’s introduce the following, additional rule for PPs:

\[
\text{PP} \rightarrow \text{PP and PP}
\]

(A PP can be formed from two other PPs joined by ‘and’).
Conjunction of Prepositional Phrases

Our Updated PS Rules:

\[
\begin{align*}
S &\rightarrow \{ \text{NP, CP} \} \text{ VP} \\
\text{NP} &\rightarrow (D) (A^*) \text{ N} (\text{CP}) (\text{PP}^*) \\
\text{NP} &\rightarrow \text{NP and NP} \\
\text{VP} &\rightarrow \text{V} (\text{NP}) \{ (\text{NP}) (\text{CP}) \} (\text{PP}^*) \\
\text{VP} &\rightarrow \text{VP and VP} \\
\text{PP} &\rightarrow \text{P} (\text{NP}) \\
\text{PP} &\rightarrow \text{PP and PP} \\
\text{CP} &\rightarrow \text{C S}
\end{align*}
\]

Dave walked out the door into the yard
Summary of Our Conjunction Rules

Our Updated PS Rules:

\[
\begin{align*}
S & \rightarrow \{ \text{NP} \,, \text{CP} \} \text{ VP} \\
\text{NP} & \rightarrow (D) \,(A^*) \, N \,(C) \,(P) \,(P^*) \\
\text{NP} & \rightarrow \text{NP and NP} \\
\text{VP} & \rightarrow V \,(NP) \,\{ \,(NP) \,(C) \,\} \,(P^*) \\
\text{VP} & \rightarrow \text{VP and VP} \\
\text{PP} & \rightarrow P \,(NP) \\
\text{PP} & \rightarrow \text{PP and PP} \\
\text{CP} & \rightarrow C \,S
\end{align*}
\]

Summary:
So far, we’ve added three different rules to our system:

- \( \text{NP} \rightarrow \text{NP and NP} \)
- \( \text{VP} \rightarrow \text{VP and VP} \)
- \( \text{PP} \rightarrow \text{PP and PP} \)
Summary of Our Conjunction Rules

Our Updated PS Rules:

\[
\begin{align*}
S & \rightarrow \{ NP , CP \} VP \\
NP & \rightarrow (D) (A^*) N (CP) (PP^*) \\
\textbf{NP} & \rightarrow \textbf{NP and NP} \\
VP & \rightarrow V (NP) \{ (NP) (CP) \} (PP^*) \\
\textbf{VP} & \rightarrow \textbf{VP and VP} \\
PP & \rightarrow P (NP) \\
\textbf{PP} & \rightarrow \textbf{PP and PP} \\
CP & \rightarrow C S
\end{align*}
\]

Problem:
These three separate rules are missing an obvious pattern!

- Wherever you can have any category X, you can also have ‘X and X’.
Summary of Our Conjunction Rules

Our Updated PS Rules:

\[
S \rightarrow \{ \text{NP, CP} \} \text{ VP} \\
\text{NP} \rightarrow (D) \ (A^*) \ N \ (CP) \ (PP^*) \\
\text{NP} \rightarrow \text{NP} \text{ and NP} \\
\text{VP} \rightarrow V \ (NP) \ \{ \ (NP) \ (CP) \ \} \ (PP^*) \\
\text{VP} \rightarrow \text{VP} \text{ and VP} \\
\text{PP} \rightarrow P \ (NP) \\
\text{PP} \rightarrow \text{PP} \text{ and PP} \\
\text{CP} \rightarrow C \ S
\]

The Conjunction ‘Meta-Rule’:

\[
X \rightarrow X \text{ and } X
\]

(Where X can be any category (N, V, A, D, P, C) or any phrase (S, NP, VP, PP, CP, etc.))
The Conjunction ‘Meta-Rule’

Our Updated PS Rules:

S → { NP , CP } VP
NP → (D) (A*) N (CP) (PP*)
VP → V (NP) { (NP) (CP) } (PP*)
PP → P (NP)
CP → C S
X → X and X

How to Read Our New Rule:
“For any label X, this is a rule of the syntax: X → X and X”

- So, our new ‘meta-rule’ makes all the following PS rules:
  - NP → NP and NP
  - VP → VP and VP
  - PP → PP and PP
The Conjunction ‘Meta-Rule’

Our Updated PS Rules:

\[
\begin{align*}
S & \rightarrow \{ \text{NP} , \text{CP} \} \text{ VP} \\
\text{NP} & \rightarrow (D) (A^*) N (\text{CP}) (\text{PP}^*) \\
\text{VP} & \rightarrow V (\text{NP}) \{ (\text{NP}) (\text{CP}) \} (\text{PP}^*) \\
\text{PP} & \rightarrow P (\text{NP}) \\
\text{CP} & \rightarrow C S \\
X & \rightarrow X \text{ and } X
\end{align*}
\]

*Our ‘meta-rule’ also makes some other PS rules we need:*
The Conjunction ‘Meta-Rule’

Our Updated PS Rules:

\[
\begin{align*}
S & \rightarrow \{ \text{NP}, \text{CP} \} \text{ VP} \\
\text{NP} & \rightarrow (\text{D}) (\text{A}^*) \text{ N} (\text{CP}) (\text{PP}^*) \\
\text{VP} & \rightarrow \text{V} (\text{NP}) \ {\{ (\text{NP}) (\text{CP}) \}} (\text{PP}^*) \\
\text{PP} & \rightarrow \text{P} (\text{NP}) \\
\text{CP} & \rightarrow \text{C} \ S \\
X & \rightarrow X \text{ and } X
\end{align*}
\]

Conjunction of Sentences:

\[
S \rightarrow S \text{ and } S
\]
The Conjunction ‘Meta-Rule’

Our Updated PS Rules:

\[
\begin{align*}
S & \rightarrow \{ \text{NP}, \text{CP} \} \text{ VP} \\
\text{NP} & \rightarrow (D) (A^*) N (\text{CP}) (\text{PP}^*) \\
\text{VP} & \rightarrow V (\text{NP}) \{ (\text{NP}) (\text{CP}) \} (\text{PP}^*) \\
\text{PP} & \rightarrow P (\text{NP}) \\
\text{CP} & \rightarrow C S \\
X & \rightarrow X \text{ and } X
\end{align*}
\]

Conjunction of CPs:

\[
\text{CP} \rightarrow \text{CP and CP}
\]

Syntax:
Recursion, Conjunction, and Constituency

Supplementary Readings
Recursion
Conjunction
The Conjunction ‘Meta-Rule’
Constituency Tests
Auxiliary Verbs
The Conjunction ‘Meta-Rule’

Our Updated PS Rules:

\[
\begin{align*}
S & \rightarrow \{ NP, CP \} \ VP \\
NP & \rightarrow (D) (A^*) N (CP) (PP^*) \\
VP & \rightarrow V (NP) \{ (NP) (CP) \} (PP^*) \\
PP & \rightarrow P (NP) \\
CP & \rightarrow C \ S \\
X & \rightarrow X \text{ and } X
\end{align*}
\]

Conjunction of Ns:

\[
N \rightarrow N \text{ and } N
\]
The Conjunction ‘Meta-Rule’

Our Updated PS Rules:

\[
S \rightarrow \{ \text{NP, CP} \} \text{ VP}
\]

\[
\text{NP} \rightarrow (D) \ (A^*) \ N \ (\text{CP}) \ (\text{PP}^*)
\]

\[
\text{VP} \rightarrow V \ (\text{NP}) \ \{ (\text{NP}) \ (\text{CP}) \} \ (\text{PP}^*)
\]

\[
\text{PP} \rightarrow P \ (\text{NP})
\]

\[
\text{CP} \rightarrow C \ S
\]

\[
X \rightarrow X \text{ and } X
\]

Conjunction of Vs:

\[
V \rightarrow V \text{ and } V
\]

\[
\text{S}
\]

\[
\text{NP}
\]

\[
\text{NP}
\]

\[
\text{N}
\]

\[
\text{Dave}
\]

\[
\text{V}
\]

\[
\text{V}
\]

\[
\text{and}
\]

\[
\text{V}
\]

\[
\text{the carrots}
\]

\[
\text{cooked}
\]

\[
\text{sliced}
\]
The Conjunction ‘Meta-Rule’

Our Updated PS Rules:

\[
\begin{align*}
S & \rightarrow \{ \ NP \ , \ CP \ \} \ VP \\
NP & \rightarrow (D) \ (A^*) \ N \ (CP) \ (PP^*) \\
VP & \rightarrow V \ (NP) \ \{ \ (NP) \ (CP) \ \} \ (PP^*) \\
PP & \rightarrow P \ (NP) \\
CP & \rightarrow C \ S \\
X & \rightarrow X \ and \ X
\end{align*}
\]

Conjunction of Ps:

\[
P \rightarrow P \ and \ P
\]
The Conjunction ‘Meta-Rule’

Our Updated PS Rules:

- \( S \rightarrow \{ NP, CP \} VP \)
- \( NP \rightarrow (D) (A^*) N (CP) (PP^*) \)
- \( VP \rightarrow V (NP) \{ (NP) (CP) \} (PP^*) \)
- \( PP \rightarrow P (NP) \)
- \( CP \rightarrow C S \)
- \( X \rightarrow X \text{ and } X \)

Vocabulary:

If two things are joined together by “and”, they are said to be:

- conjoined
- coordinated
Phrases and ‘Constituents’

Vocabulary:
If a group of words in a sentence form a phrase *on their own*, they are said to be a **constituent**.

Illustration: “Dave likes the happy man.”

![Syntax diagram](image)

- ‘the happy man’ is a **constituent**
  (Those words together *on their own* form a phrase in the sentence: the NP)
Phrases and ‘Constituents’

Vocabulary:
If a group of words in a sentence form a phrase on their own, they are said to be a constituent.

Illustration: “Dave likes the happy man.”

- ‘likes the happy man’ is a constituent
(Those words together on their own form a phrase in the sentence: the VP)
Phrases and ‘Constituents’

Vocabulary:
If a group of words in a sentence form a phrase on their own, they are said to be a constituent.

Illustration: “Dave likes the happy man.”

\[
S \\
| NP | VP \\
| | \\
| N | V | NP \\
| | | \\
| Dave | likes | D | A | N \\
| | | | | \\
| the | happy | man |
\]

► ‘the happy’ is not a constituent
(Those words on their own don’t form a phrase in the sentence)
Phrases and ‘Constituents’

Vocabulary:
If a group of words in a sentence form a phrase on their own, they are said to be a constituent.

Illustration: “Dave likes the happy man.”

Syntax:
Recursion, Conjunction, and Constituency

Supplementary Readings
Recursion
Conjunction
Constituency Tests
Conjunction
Degree Expressions (Deg)
Question by Repetition
Auxiliary Verbs

▶ ‘likes the’ is not a constituent
(Those words on their own don’t form a phrase in the sentence)
Tests for Constituency

Question:

- Suppose I don’t already know the right structure for a sentence...
- How can I tell whether some bunch of words is actually a constituent of not?
Tests for Constituency

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- How can I tell whether some bunch of words is actually a constituent of not?

Answer:
There are some tests you can use!

- Linguists call these ‘constituency tests’.
- The first involves ‘conjunction’ (joining things with ‘and’).
Conjunction as Constituency Test

Our ‘Meta-Rule’ for Conjunction: \( X \rightarrow X \text{ and } X \)

- This rule says that ‘and’ can only go between two phrases of the same type.
  - NP \( \rightarrow \) NP and NP
  - VP \( \rightarrow \) VP and VP
  - PP \( \rightarrow \) PP and PP
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Important Consequence of the ‘Meta-Rule’:

- Suppose some words ‘X Y Z’ are a constituent.
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Important Consequence of the ‘Meta-Rule’:
- Suppose some words ‘X Y Z’ are a constituent.
- Then, they together form a phrase of some type ‘XP’
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Illustration: “Dave likes the happy man”
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Illustration: “Dave likes the happy man”
- ‘The happy man’ is a constituent (an NP).
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Illustration: “Dave likes the happy man”

- ‘The happy man’ is a constituent (an NP).
- And, so we can follow it with ‘and’ plus a sequence of words of the same categories:
  (Dave likes the happy man and some angry cat)
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Illustration: “Dave likes the happy man”
- ‘Likes the happy man’ is a constituent (a VP).
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  (Dave likes the happy man and hates some angry cat)
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Illustration: “Dave likes the happy man”
- ‘The happy’ is not a constituent.
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- ‘The happy’ is not a constituent.
- And so we can’t follow it with ‘and’ plus a sequence of words of the same categories.
  (*Dave likes the happy and some angry man)
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Illustration: “Dave likes the happy man”
- ‘Likes the’ is not a constituent.
- And so we can’t follow it with ‘and’ plus a sequence of words of the same categories.
  (*Dave likes the and saw the happy man)
Applying the Test to a New Case

The Main Consequence:
If we’re not sure if some bunch of words forms a constituent, we can use conjunction as a test:

I Take that sequence of words, follow it with ‘and’ plus a sequence of words of the same categories.
I If it sounds good, it’s a constituent!
I If it sounds bad, it’s not a constituent!

Let’s now try this out on a new case!

Degree Expressions:
I “The very tall man left.”
I The category of ‘very’ is a ‘Degree Expression’ (Deg).
I Other Degs include: too, kinda, more, most, least, ...
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Degs and Constituency

Question:
In the sentence “The very tall man left”, do the Deg ‘very’ and the adjective ‘tall’ form a constituent?
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- That is, which of these tree structures is correct?:

![Tree structures of the sentence “The very tall man left”]

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Our ‘Conjunction Test’: “The very tall man left.”

Take “very tall”, follow it with ‘and’ plus a sequence of words of the same category (a Deg and an A).

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Take “very tall”, follow it with ‘and’ plus a sequence of words of the same category (a Deg and an A).

- If it sounds good, it’s a constituent!
- If it sounds bad, it’s not a constituent!

Result: “very tall” passes the test!

- The following sentence sounds totally fine:
  “The very tall and kinda handsome man left.”
**Degs and Constituency**

Our ‘Conjunction Test’: “The **very tall** man left.”

Take “very tall”, follow it with ‘and’ plus a sequence of words of the same category (a Deg and an A).

- If it sounds good, it’s a constituent!
- If it sounds bad, it’s *not* a constituent!

![Syntax Tree]

- **NP**: The **very tall** kinda handsome man
- **VP**: **and**
- **Deg**: **very**
- **A**: **tall**
- **Deg**: **kinda**
- **A**: **handsome**
Degs and Constituency

Our ‘Conjunction Test’: “The very tall man left.”

Take “very tall”, follow it with ‘and’ plus a sequence of words of the same category (a Deg and an A).

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Take “very tall”, follow it with ‘and’ plus a sequence of words of the same category (a Deg and an A).

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In the sentence “The very tall man left”, do the Deg ‘very’ and the adjective ‘tall’ form a constituent?
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- The following sentence sounds totally fine:
  “The very tall and kinda handsome man left.”

Question:
In the sentence “The very tall man left”, do the Deg ‘very’ and the adjective ‘tall’ form a constituent?

Answer:
Yes; ‘very’ and ‘tall’ do form a constituent in this sentence!
Adjective Phrases

Question:
What’s the rule that combines a Deg (‘very’) and an A (‘tall’) into a phrase?

I. We’ll call this type of a phrase an Adjective Phrase (AP)
Since it consists of a Deg and an A, the PS rule would be:
AP ![ Deg ] A

Our Updated PS Rules:

Adjective Phrases

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Our Updated PS Rules:
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\text{VP} &\to V \ (\text{NP}) \ \{ (\text{NP}) \ (\text{CP}) \} \ (\text{PP}^*) \\
\text{PP} &\to P \ (\text{NP}) \\
\text{CP} &\to C \ S \\
\text{AP} &\to (\text{Deg}) A \\
X &\to X \ \text{and} \ X
\end{align*}
\]
Besides this, linguists have many other ‘tests’ for whether a bunch of words forms a constituent.

In this class, we’ll learn just one more... (More are discussed in the reading...)

Auxiliary Verbs
Questioning by Repetition

Basic Fact:
We can ‘call things into question’ by repeating them in a quizzical fashion:

- Person 1: “Dave is dating a lawyer.”
- Person 2: “A lawyer?!?”
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In such dialogs, we can only ‘quizzically repeat’ a constituent.
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- Person 2: * “likes the?!?”
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- Person 2: “Likes the happy man?!?”
- Person 2: “The happy man?!?”
- Person 2: * “the happy?!?”
- Person 2: * “likes the?!?”

The Rationale:
If something is not a ‘constituent’, then it’s not a full phrase, and it’s ‘weird’ not to speak in full phrases...
Questioning by Repetition

Crucial Fact:
In dialogs, we can only ‘quizzically repeat’ a constituent.
Questioning by Repetition

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The Constituency Test:
If we’re not sure if some bunch of words forms a constituent, we can use ‘quizzical repetition’ as a test:
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If we’re not sure if some bunch of words forms a constituent, we can use ‘quizzical repetition’ as a test:

- Imagine someone says the sentence, and then try to ‘quizzically repeat’ those words.
  - If it sounds natural, then those words form a constituent!
  - If it doesn’t, they don’t form a constituent!
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Illustration: “Dave walked into the house”

- Our rules predict that ‘walked’ and ‘into the house’ form a constituent (VP).
Questioning by Repetition

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Illustration: “Dave walked into the house”

- Our rules predict that ‘walked’ and ‘into the house’ form a constituent (VP).
- Our ‘repetition test’ for constituency confirms this.
  - Person 1: Dave walked into the house.
  - Person 2: Walked into the house?!?
Sentences With Multiple Verbs

Our Current PS Rules:

\[
\begin{align*}
S & \rightarrow \{ \text{NP, CP} \} \text{ VP} \\
\text{NP} & \rightarrow (D) (\text{AP}^*) \text{ N} (\text{CP}) (\text{PP}^*) \\
\text{VP} & \rightarrow \text{ V} (\text{NP}) \{ (\text{NP}) (\text{CP}) \} (\text{PP}^*) \\
\text{PP} & \rightarrow \text{ P} (\text{NP}) \\
\text{CP} & \rightarrow \text{ C S} \\
\text{AP} & \rightarrow (\text{Deg}) \text{ A} \\
\text{X} & \rightarrow \text{ X and X}
\end{align*}
\]

Problem:

- Our PS rules only let a single sentence have a single V:
- However, sentences can seem to have more than one V:
  - Dave has bought a car.
  - Dave did buy a car.
  - Dave is buying a car.
  - Dave will buy a car.
Auxiliary Verbs

The Challenge:
Fix our rules so that sentences with multiple Vs are possible:

- Dave has bought a car.
- Dave did buy a car.
- Dave is buying a car.
- Dave will buy a car.
Auxiliary Verbs

The Challenge:
Fix our rules so that sentences with multiple Vs are possible:

► Dave has bought a car.
► Dave did buy a car.
► Dave is buying a car.
► Dave will buy a car.

Key Observation:

► In these kinds of Ss, the first V isn’t just any old verb of English.
► Rather, it can only be one of very limited group:
  (has, did, is, will, can, must, should, ...)

Vocabulary
Auxiliary Verb (Aux) = a V that can directly precede another V in an English sentence (has, did, is, will, can, must, should, ...)
Auxiliary Verbs

The Challenge:
Fix our rules so that sentences with multiple Vs are possible:

- Dave *has* bought a car.
- Dave *did* buy a car.
- Dave *is* buying a car.
- Dave *will* buy a car.

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- In these kinds of Ss, the first V isn’t just any old verb of English.
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Vocabulary

**Auxiliary Verb (Aux)** =
a V that can directly precede another V in an English sentence
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Auxiliary Verbs

The Challenge:
Fix our rules so that sentences with multiple Vs are possible:

- Dave has bought a car.
- Dave did buy a car.
- Dave is buying a car.
- Dave will buy a car.

Key Question:
In sentences like those above, does the Aux form a constituent with the VP?

```
S
  NP  Aux  VP
  |    |     
  N   has bought a car
  Dave

S
  NP  Aux  VP
  |    |     
  N   has bought a car
  Dave
```
Applying Our Constituency Tests!

Key Fact:
The sequence ‘Aux VP’ *does* pass our constituency tests!
Applying Our Constituency Tests!

Key Fact:
The sequence ‘Aux VP’ does pass our constituency tests!

1. The Conjunction Test:
The sequence ‘Aux VP’ can be followed by ‘and’ plus another ‘Aux VP’ sequence:

   ▶ Dave has bought a car and will buy a house.
Applying Our Constituency Tests!

Key Fact:
The sequence ‘Aux VP’ does pass our constituency tests!

1. The Conjunction Test:
The sequence ‘Aux VP’ can be followed by ‘and’ plus another ‘Aux VP’ sequence:
   - Dave has bought a car and will buy a house.

2. The Repetition Test:
The sequence ‘Aux VP’ can be ‘quizzically repeated’
   - Person 1: ‘Dave will buy a house.”
   - Person 2: ‘Will buy a house?!?”
Applying Our Constituency Tests!

Key Fact:
The sequence ‘Aux VP’ does pass our constituency tests!

1. The Conjunction Test:
The sequence ‘Aux VP’ can be followed by ‘and’ plus another ‘Aux VP’ sequence:
   - Dave has bought a car **and** will buy a house.

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The sequence ‘Aux VP’ can be ‘quizzically repeated’
   - Person 1: ‘Dave will buy a house.’
   - Person 2: ‘Will buy a house?!?’

Conclusion:
The ‘Aux’ does form a constituent with the VP that follows it.
The Rule for Auxiliary Verbs

Conclusion:
The ‘Aux’ *does* form a constituent with the VP that follows it.

![Syntax Tree]

**S**

- **NP**
  - **N** Dave
  - **Aux** has
  - **VP** bought a car
The Rule for Auxiliary Verbs

Conclusion:
The ‘Aux’ *does* form a constituent with the VP that follows it.

```
S
  /\   ??
NP /    
   /   
  N    Aux    VP
   |     /    |
Dave has bought a car
```

Question:
What is the type of phrase that the Aux and the VP make?
The Rule for Auxiliary Verbs

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```
  S
 /   \
|    |
|    |
NP ??  VP
|    |
|    |
  N  Aux
   |    |
   |    |
Dave has bought a car
```

Question:
What is the type of phrase that the Aux and the VP make?

Answer:
Well, it looks like just another VP!

- It comes together with an NP or CP to make an S
- Wherever you have a ‘plain VP’, you can have ‘Aux VP’
The Rule for Auxiliary Verbs

Conclusion:
The ‘Aux’ *does* form a constituent with the VP that follows it.

```
S
  NP
    N
    Dave
  VP
    Aux
    has
    bought a car
```

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- \( \text{VP} \rightarrow \text{V} (\text{NP}) \{ (\text{NP}) (\text{CP}) \} (\text{PP}^*) \)
- \( \text{VP} \rightarrow \text{Aux} \ \text{VP} \)
- \( \text{PP} \rightarrow \text{P} (\text{NP}) \)
- \( \text{CP} \rightarrow \text{C} \ \text{S} \)
- \( \text{AP} \rightarrow (\text{Deg}) \ \text{A} \)
- \( \text{X} \rightarrow \text{X} \ \text{and} \ \text{X} \)
Recursion in the VP

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\[
\begin{align*}
S & \rightarrow \{ NP, CP \} \ VP \\
NP & \rightarrow (D) (AP^*) N (CP) (PP^*) \\
VP & \rightarrow V (NP) \{ (NP) (CP) \} (PP^*) \\
VP & \rightarrow \text{Aux} \ VP \\
PP & \rightarrow P (NP) \\
CP & \rightarrow C S \\
AP & \rightarrow (Deg) A \\
X & \rightarrow X \text{ and } X
\end{align*}
\]

Interesting Consequence:

Our new VP rule creates another case of recursion:

- According to the rule, a VP can directly contain another VP
Recursion in the VP

Our Updated PS Rules:

\[
S \rightarrow \{ NP , CP \} VP \\
NP \rightarrow (D) (AP^*) N (CP) (PP^*) \\
VP \rightarrow V (NP) \{ (NP) (CP) \} (PP^*) \\
VP \rightarrow Aux \ VP \\
PP \rightarrow P (NP) \\
CP \rightarrow C S \\
AP \rightarrow (Deg) A \\
X \rightarrow X \text{ and } X
\]

Interesting Consequence:
Our new VP rule creates another case of recursion:

- According to the rule, a VP can directly contain another VP

Important Prediction:
Because this recursion, our new PS rule lets us have multiple Aux’s in a single sentence!
Recursion in the VP

Important Prediction:

Our new PS rule for auxiliaries \((\text{VP} \rightarrow \text{Aux VP})\) lets us have multiple Aux’s in a single sentence.

`S`

`NP` / `VP`

`N` / `Aux`

`Dave` / `might`

`have`

`Aux`

`have`

`Aux`

`been`

`drinking whiskey`
Limits to Recursion in the VP

Problematic Prediction:
Our PS rule for auxiliaries (VP → Aux VP) wrongly allows us to have an unlimited number of Aux’s in a single sentence.
Limits to Recursion in the VP

Problematic Prediction:
Our PS rule for auxiliaries ($\text{VP} \rightarrow \text{Aux VP}$) wrongly allows us to have an unlimited number of Aux’s in a single sentence.

The Solution?
You’ll have to take Linguistics 401 (Introduction to Syntax)