The Basics of Syntax
Course Readings

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

- Language Files: Chapter 5 (pp. 194-198, 204-215)
- Language Instinct: Chapter 4 (pp. 74-99)
The System Thus Far

The Fundamental Question:
What are the rules and mental representations that underlie our ability to speak and understand a language?

The Answer Thus Far:

▶ Mental Representations:
  ▶ A ‘mental lexicon’ listing the morphemes (words and affixes) of the language.
  ▶ For each morpheme, a representation of the phonemes that constitute it.

▶ The Rules:
  ▶ Morphology: Rules for combining morphemes into words.
    ▶ Right Hand Head Rule, Morphophonemtics
  ▶ Phonology: Rules affecting how the word is pronounced.
    ▶ The Syllabification Rule, Aspiration Rule, etc...
And Now...Syntax!

In This Unit:
We will explore a third major category of rules and representations, those that concern *sentences*.

Vocabulary: **Syntax**

- The rules of sentence formation.
- The rules that state **how words can be combined into sentences**.

The dog chased the cat. * Dog the cat chased the.
Rules and Categories of Words

Crucial Fact:

- The rules for making sentences don’t refer to specific words (e.g. ‘dog’, ‘run’)
- Rather, they refer to *types* or *categories* of words (e.g. ‘noun’, ‘verb’)

Illustration:

1. NOT a Realistic Syntactic Rule:
   “A sentence can be formed from ‘Dave’ and ‘danced’”

2. A More Realistic Syntactic Rule:
   “A sentence can be formed from a noun and a verb”
Rules and Categories of Words

Crucial Fact:

- The rules for making sentences don’t refer to specific words (e.g. ‘dog’, ‘run’)
- Rather, they refer to *types* or *categories* of words (e.g. ‘noun’, ‘verb’)

Illustration:

1. NOT a Realistic Syntactic Rule:
   “A sentence can be formed from ‘Dave’ and ‘danced’”

2. A More Realistic Syntactic Rule:
   “A sentence can be formed from a **noun** and a **verb**”

Evidence:

- If all we had were rules like (1), we’d need a *ridiculous* number of them (separate rules for ‘cat’, ‘dog’, ‘duck’, ‘desk’?!)
- When speakers learn a new word, they immediately know how to form sentences with it.
The Generality of Syntactic Rules

Fact:
When speakers learn a new word, they immediately know how to form sentences with it.
The Generality of Syntactic Rules

Fact:
When speakers learn a new word, they immediately know how to form sentences with it.

▶ Imagine ‘snerd’ = ‘game that can be won in under 10 hours’
The Generality of Syntactic Rules

Fact:
When speakers learn a new word, they immediately know how to form sentences with it.

- Imagine ‘snerd’ = ‘game that can be won in under 10 hours’
- Knowing only this, you immediately know that these are all good-sounding sentences:
  - This game is a real **snerd**.
  - Don’t buy that **snerd**.
  - **Snerds** really annoy me.
The Generality of Syntactic Rules

Fact:
When speakers learn a new word, they immediately know how to form sentences with it.

- Imagine ‘snerd’ = ‘game that can be won in under 10 hours’
- Knowing only this, you immediately know that these are all good-sounding sentences:
  - This game is a real **snerd**.
  - Don’t buy that **snerd**.
  - **Snerds** really annoy me.

- You also know that these are not good-sounding sentences:
  - * I **snerd** every weekend.
  - * I play very **snerd**.
The Generality of Syntactic Rules

Fact: When speakers learn a new word, they immediately know how to form sentences with it.

Conclusion:

▶ Even though you hadn’t heard ‘snerd’ in a sentence, you knew right away how to use it in sentences.
▶ So, **knowing how to use ‘snerd’ couldn’t be based in rules specific to ‘snerd’** (cause you weren’t shown any).
The Generality of Syntactic Rules

Fact:
When speakers learn a new word, they immediately know how to form sentences with it.

Conclusion:
- Even though you hadn’t heard ‘snerd’ in a sentence, you knew right away how to use it in sentences.
- So, knowing how to use ‘snerd’ couldn’t be based in rules specific to ‘snerd’ (cause you weren’t shown any).
- So, the rules for forming sentences don’t refer to specific words (e.g. ‘snerd’), but to categories of words (e.g. ‘noun’).
The Generality of Syntactic Rules

Fact:
When speakers learn a new word, they immediately know how to form sentences with it.

Conclusion:
- Even though you hadn’t heard ‘snerd’ in a sentence, you knew right away how to use it in sentences.
- So, knowing how to use ‘snerd’ couldn’t be based in rules specific to ‘snerd’ (cause you weren’t shown any).
- So, the rules for forming sentences don’t refer to specific words (e.g. ‘snerd’), but to categories of words (e.g. ‘noun’)
  - When you learned ‘snerd’, you could tell it was a noun.
  - Knowing this, the rules for nouns in English told you how to form sentences with it.
Syntactic Categories

Crucial Fact:

- The rules for making sentences don’t refer to specific words (e.g. ‘dog’, ‘run’)
- Rather, they refer to *types* or *categories* of words (e.g. ‘noun’, ‘verb’)

Vocabulary:

**Syntactic category** (‘lexical category’, ‘part of speech’) = the word categories that the rules of syntax make reference to

- Many of these will be familiar to you from language classes...
Syntactic Categories

Noun: (N)

- Examples:
  dog, cat, man, boy, table, death, happiness, snerd
- Main Characteristic:
  Nouns can appear alone after “the”: (the dog, the cat, the death, the happiness, the snerd)
Syntactic Categories

**Noun:** (N)

- Examples:
  - dog, cat, man, boy, table, death, happiness, snerd
- Main Characteristic:
  - Nouns can appear alone after “the”:
    (the dog, the cat, the death, the happiness, the snerd)

**Verb:** (V)

- Examples:
  - jump, laugh, run, carry, hit, love, snow, ponder
- Main Characteristic:
  - Verbs can appear alone after “will”
    (will jump, will run, will love, will ponder)
Syntactic Categories

Noun: (N)

- Examples:
  dog, cat, man, boy, table, death, happiness, snerd

- Main Characteristic:
  Nouns can appear alone after “the”:
  (the dog, the cat, the death, the happiness, the snerd)

Verb: (V)

- Examples:
  jump, laugh, run, carry, hit, love, snow, ponder

- Main Characteristic:
  Verbs can appear alone after “will”
  (will jump, will run, will love, will ponder)

Adjective: (A)

- Examples:
  happy, tall, little, wonderful, former, ugly, doable

- Main Characteristic:
  Adjective can come between “the” and a N
  (the happy dog, the former mayor, the doable idea)
Definitions of Noun, Verb, Adjective?

**Question:**
But wait, didn’t we learn back in grade school that:

- Noun = ‘a person, place or thing’?
- Verb = ‘an action’?
- Adjective = ‘a quality’?
Definitions of Noun, Verb, Adjective?

Question:
But wait, didn’t we learn back in grade school that:

- Noun = ‘a person, place or thing’?
- Verb = ‘an action’?
- Adjective = ‘a quality’?

Answer:
Those definitions aren’t *totally* correct:

- Not all verbs describe actions (‘love’, ‘know’)
- Not all adjectives describe qualities (‘former’)
- Saying ‘nouns’ describe ‘things’ is empty: (anything can be a ‘thing’, including actions)
Definitions of Noun, Verb, Adjective?

Question: But wait, didn’t we learn back in grade school that:

▶ Noun = ‘a person, place or thing’?
▶ Verb = ‘an action’?
▶ Adjective = ‘a quality’?

Answer: The correct definitions are in terms of where in a sentence they can go:

▶ A ‘noun’ can (e.g.) come alone right after “the”
▶ A ‘verb’ can (e.g.) come alone right after “will”
▶ An ‘adjective’ can (e.g.) come between “the” and a noun.
Some More Syntactic Categories

Here are some more syntactic categories, which may be new to you....

**Determiner:** (D)

- Examples:
  - the, a, some, every, no, most
- Main Characteristic: (don’t worry about this for now)

**Preposition:** (P)

- Examples:
  - to, for, of, in, with, over, under, without, inside
- Main Characteristic: (don’t worry about this for now)
Towards Phrase Structure Rules

What We Know So Far:

- Languages have rules for forming sentences.
- The rules don’t refer to specific words, but to word categories.
- The word categories (for now) are: N, V, A, D, P

Now, let’s start figuring out the actual rules!
Towards Phrase Structure Rules

What We Know So Far:

- Languages have rules for forming sentences.
- The rules don’t refer to specific words, but to word categories.
- The word categories (for now) are: N, V, A, D, P

Now, let’s start figuring out the actual rules!

Opening Observation:
You can form a sentence of English by combining a N and a V.

- Dogs run.
- Boys dance.
- Girls laugh.

A Formal Notation:
S → N V

“A sentence can be formed from a noun followed by a verb”
The Basics of Phrase Structure Rules

A Formal Notation:

\[ S \rightarrow N \ V \]

“A sentence can be formed from a noun followed by a verb”

- Rules in this notation are **phrase structure rules**.
- They look like our earlier morphology rules...
  - Except there is no ‘+’ after the arrow.
  - Because these rules make **phrases**, not words.
The Basics of Phrase Structure Rules

A Formal Notation:

\[ S \rightarrow N \, V \]

“A sentence can be formed from a noun followed by a verb”

- Rules in this notation are **phrase structure rules**.
- They look like our earlier morphology rules...
  - Except there is no ‘+’ after the arrow.
  - Because these rules make **phrases**, not words
- As in our morphology unit, we can use ‘tree structures’ to illustrate the way these rules make larger structures:

```
S --> N  V
  |      |
  N     V
  |      |
  Dogs  run
```

```
S --> N  V
  |      |
  N     V
  |      |
  Boys  dance
```

```
S --> N  V
  |      |
  N     V
  |      |
  Girls laugh
```

“The noun ‘dogs’ combines with the verb ‘run’ to make a sentence”
Towards Noun Phrases

Observation 1:

- There are many more rules to English syntax besides ‘S → N V’
- There are many sentences that can’t be formed from this rule.

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dogs chase cats</td>
<td></td>
</tr>
</tbody>
</table>
Towards Noun Phrases

Observation 1:
- There are many more rules to English syntax besides ‘S → N V’
- There are many sentences that can’t be formed from this rule.

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dogs chase cats</td>
<td>S → N V N</td>
</tr>
</tbody>
</table>
Towards Noun Phrases

Observation 1:
- There are many more rules to English syntax besides ‘S → N V’
- There are many sentences that can’t be formed from this rule.

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dogs chase cats</td>
<td>S → N V N</td>
</tr>
<tr>
<td>Some dogs chased the cats</td>
<td></td>
</tr>
</tbody>
</table>
Towards Noun Phrases

Observation 1:

- There are many more rules to English syntax besides ‘S → N V’
- There are many sentences that can’t be formed from this rule.

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dogs chase cats</td>
<td>S → N V N</td>
</tr>
<tr>
<td>Some dogs chased the cats</td>
<td>S → D N V D N</td>
</tr>
</tbody>
</table>
Towards Noun Phrases

Observation 1:
- There are many more rules to English syntax besides \( S \rightarrow N V \)
- There are many sentences that can’t be formed from this rule.

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dogs chase cats</td>
<td>( S \rightarrow N V N )</td>
</tr>
<tr>
<td>Some dogs chased the cats</td>
<td>( S \rightarrow D N V D N )</td>
</tr>
<tr>
<td>Old dogs chased young cats</td>
<td></td>
</tr>
</tbody>
</table>
Towards Noun Phrases

Observation 1:

- There are many more rules to English syntax besides \( S \rightarrow N \ V \)
- There are many sentences that can’t be formed from this rule.

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dogs chase cats</td>
<td>( S \rightarrow N \ V \ N )</td>
</tr>
<tr>
<td>Some dogs chased the cats</td>
<td>( S \rightarrow D \ N \ V \ D \ N )</td>
</tr>
<tr>
<td>Old dogs chased young cats</td>
<td>( S \rightarrow A \ N \ V \ A \ N )</td>
</tr>
</tbody>
</table>
Towards Noun Phrases

Observation 1:

- There are many more rules to English syntax besides ‘S → N V’
- There are many sentences that can’t be formed from this rule.

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dogs chase cats</td>
<td>S → N V N</td>
</tr>
<tr>
<td>Some dogs chased the cats</td>
<td>S → D N V D N</td>
</tr>
<tr>
<td>Old dogs chased young cats</td>
<td>S → A N V A N</td>
</tr>
<tr>
<td>Some old dogs chased the young cats</td>
<td></td>
</tr>
</tbody>
</table>
Towards Noun Phrases

Observation 1:

- There are many more rules to English syntax besides ‘S → N V’
- There are many sentences that can’t be formed from this rule.

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dogs chase cats</td>
<td>S → N V N</td>
</tr>
<tr>
<td>Some dogs chased the cats</td>
<td>S → D N V D N</td>
</tr>
<tr>
<td>Old dogs chased young cats</td>
<td>S → A N V A N</td>
</tr>
<tr>
<td>Some old dogs chased the young cats</td>
<td>S → D A N V D A N</td>
</tr>
</tbody>
</table>
Towards Noun Phrases

Observation 1:
- There are many more rules to English syntax besides ‘S → N V’
- There are many sentences that can’t be formed from this rule.

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dogs chase cats</td>
<td>S → N V N</td>
</tr>
<tr>
<td>Some dogs chased the cats</td>
<td>S → D N V D N</td>
</tr>
<tr>
<td>Old dogs chased young cats</td>
<td>S → A N V A N</td>
</tr>
<tr>
<td>Some old dogs chased the young cats</td>
<td>S → D A N V D A N</td>
</tr>
</tbody>
</table>

Observation 2:
- All these rules above are getting tedious...
- They are also missing an obvious pattern:

The Pattern:
Wherever English allows N, it also allows (i) D N, (ii) A N, (iii) D A N.
Towards Noun Phrases

Observation 1:
- There are many more rules to English syntax besides ‘S → N V’
- There are many sentences that can’t be formed from this rule.

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dogs chase cats</td>
<td>S → N V N</td>
</tr>
<tr>
<td>Some dogs chased the cats</td>
<td>S → D N V D N</td>
</tr>
<tr>
<td>Old dogs chased young cats</td>
<td>S → A N V A N</td>
</tr>
<tr>
<td>Some old dogs chased the young cats</td>
<td>S → D A N V D A N</td>
</tr>
</tbody>
</table>

Observation 2:
- All these rules above are getting tedious...
- They are also missing an obvious pattern:

The Pattern:
Wherever English allows N, it also allows (i) D N, (ii) A N, (iii) D A N.
The Noun Phrase

The Pattern:
Wherever English allows N, it also allows (i) D N, (ii) A N, (iii) D A N.
The Basics of Syntax

Course Readings
Introduction
Lexical Categories
Phrase Structure
Rules
Introducing Noun Phrases
Some Further Details
Introducing Verb Phrases
Introducing Prepositional Phrases
Summary

The Noun Phrase

The Pattern:
Wherever English allows N, it also allows (i) D N, (ii) A N, (iii) D A N.

Capturing the Pattern:

▶ English treats all these as ‘the same kind of thing’:
  N   D N   A N   D A N
The Noun Phrase

The Pattern:
Wherever English allows N, it also allows (i) D N, (ii) A N, (iii) D A N.

Capturing the Pattern:

- English treats all these as ‘the same kind of thing’:
  
  \[
  N \quad D \quad N \quad A \quad N \quad D \quad A \quad N
  \]

- Let’s call this kind of ‘thing’ a **Noun Phrase (NP)**
The Basics of Syntax

Course Readings
Introduction
Lexical Categories
Phrase Structure Rules
Introducing Noun Phrases
Some Further Details
Introducing Verb Phrases
Introducing Prepositional Phrases
Summary

The Noun Phrase

The Pattern:
Wherever English allows N, it also allows (i) D N, (ii) A N, (iii) D A N.

Capturing the Pattern:

- English treats all these as ‘the same kind of thing’:
  
  \[ N \quad D N \quad A N \quad D A N \]

- Let’s call this kind of ‘thing’ a **Noun Phrase (NP)**

- The following rules now capture ‘The Pattern’

  - NP → N
  - NP → D N
  - NP → A N
  - NP → D A N
The Noun Phrase

The Pattern:
Wherever English allows N, it also allows (i) D N, (ii) A N, (iii) D A N.

Capturing the Pattern:

- English treats all these as ‘the same kind of thing’:
  \[
  N \quad D \quad N \quad A \quad N \quad D \quad A \quad N
  \]
- Let’s call this kind of ‘thing’ a **Noun Phrase (NP)**
- The following rules now capture ‘The Pattern’
  - \( NP \rightarrow N \)
  - \( NP \rightarrow D \quad N \)
  - \( NP \rightarrow A \quad N \)
  - \( NP \rightarrow D \quad A \quad N \)
- We can now also simplify our rules for sentences to just these:
  - \( S \rightarrow NP \quad V \)
  - \( S \rightarrow NP \quad V \quad NP \)
Noun Phrases in Tree Structures

Our Phrase Structure Rules

<table>
<thead>
<tr>
<th>PS Rules for NPs</th>
<th>PS Rules for Sentences</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP → N</td>
<td>S → NP V</td>
</tr>
<tr>
<td>NP → D N</td>
<td>S → NP V NP</td>
</tr>
<tr>
<td>NP → A N</td>
<td></td>
</tr>
<tr>
<td>NP → D A N</td>
<td></td>
</tr>
</tbody>
</table>

We can use tree structures to show how these rules apply to make sentences:

```
S
  NP
    V
      D
      N
  run
  some
dogs
```

"Some dogs run"
Noun Phrases in Tree Structures

Our Phrase Structure Rules

**PS Rules for NPs**
- NP → N
- NP → D N
- NP → A N
- NP → D A N

**PS Rules for Sentences**
- S → NP V
- S → NP V NP

We can use tree structures to show how these rules apply to make sentences:

```
S
  NP  V
    D  N  run
      some  dogs
```

“Some dogs run”
Noun Phrases in Tree Structures

Our Phrase Structure Rules

<table>
<thead>
<tr>
<th>PS Rules for NPs</th>
<th>PS Rules for Sentences</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP → N</td>
<td>S → NP V</td>
</tr>
<tr>
<td>NP → D N</td>
<td>S → NP V NP</td>
</tr>
<tr>
<td>NP → A N</td>
<td></td>
</tr>
<tr>
<td>NP → D A N</td>
<td></td>
</tr>
</tbody>
</table>

We can use tree structures to show how these rules apply to make sentences:

```
S
   /\   ___    ___   ___
 NP   V   NP
     |   |   |
 D    A   N  chase  A   N
 |     |   |        |     |   |
 the  young cats  old  dogs
```

“She the young cats chase old dogs”
Noun Phrases in Tree Structures

Our Phrase Structure Rules

**PS Rules for NPs**

<table>
<thead>
<tr>
<th>Rule</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP → N</td>
<td>Noun phrase</td>
</tr>
<tr>
<td>NP → D N</td>
<td>Determiner + Noun</td>
</tr>
<tr>
<td>NP → A N</td>
<td>Adjective + Noun</td>
</tr>
<tr>
<td>NP → D A N</td>
<td>Determiner + Adjective + Noun</td>
</tr>
</tbody>
</table>

**PS Rules for Sentences**

<table>
<thead>
<tr>
<th>Rule</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S → NP V</td>
<td>Subject + Verb</td>
</tr>
<tr>
<td>S → NP V NP</td>
<td>Subject + Verb + NP</td>
</tr>
</tbody>
</table>

We can use tree structures to show how these rules apply to make sentences:

```
(S
  (NP Dogs)
  (V chase)
  (NP (D most) (N cats)))
```

“Dogs chase most cats”
### Condensing our Rules for NPs

#### Our Phrase Structure Rules

<table>
<thead>
<tr>
<th>PS Rules for NPs</th>
<th>PS Rules for Sentences</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NP</strong> → N</td>
<td><strong>S</strong> → <strong>NP</strong> V</td>
</tr>
<tr>
<td><strong>NP</strong> → <strong>D</strong> <strong>N</strong></td>
<td><strong>S</strong> → <strong>NP</strong> V <strong>NP</strong></td>
</tr>
<tr>
<td><strong>NP</strong> → <strong>A</strong> <strong>N</strong></td>
<td></td>
</tr>
<tr>
<td><strong>NP</strong> → <strong>D</strong> <strong>A</strong> <strong>N</strong></td>
<td></td>
</tr>
</tbody>
</table>

Now let's try simplifying our PS rules for NPs a little.
Condensing our Rules for NPs

Our Phrase Structure Rules

**PS Rules for NPs**

\[
\begin{align*}
\text{NP} & \rightarrow \text{N} \\
\text{NP} & \rightarrow \text{D N} \\
\text{NP} & \rightarrow \text{A N} \\
\text{NP} & \rightarrow \text{D A N}
\end{align*}
\]

**PS Rules for Sentences**

\[
\begin{align*}
\text{S} & \rightarrow \text{NP V} \\
\text{S} & \rightarrow \text{NP V NP}
\end{align*}
\]

Now let’s try simplifying our PS rules for NPs a little.

What These Rules Say:

- An NP has to have a N in it.
- An NP can (but need not) also contain a D and/or an A.
- If there is a D, it has to precede the N and any A.
- If there is an A, it has to precede the N and follow any D.
The Basics of Syntax

Course Readings
Introduction
Lexical Categories
Phrase Structure Rules
Introducing Noun Phrases
Some Further Details
Parenthesis Notation
Accessing the ‘Mental Lexicon’
Introducing Verb Phrases
Introducing Prepositional Phrases
Summary

The Parentheses Notation

Parentheses in PS Rules:
If a PS rule has something in parentheses, that means the thing is *optional*.

▶ Illustration:

\[
NP \rightarrow (D) (A) N
\]

‘NP can be made from optional D, optional A, and N’
The Parentheses Notation

Parentheses in PS Rules:
If a PS rule has something in parentheses, that means the thing is *optional*.

▶ Illustration:
NP → (D) (A) N
‘NP can be made from optional D, optional A, and N’

What This Rule Says:
▶ An NP has to have a N in it.
▶ An NP can (but need not) also contain a D and/or an A
▶ If there is a D, it has to precede the N and any A
▶ If there is an A, it has to precede the N and follow any D.

Conclusion:
This one rule (with parentheses) can replace our four earlier rules for NPs.
The Parentheses Notation

Parentheses in PS Rules:
If a PS rule has something in parentheses, that means the thing is optional.

▶ Illustration:
NP → (D) (A) N
‘NP can be made from optional D, optional A, and N’

Our New Phrase Structure Rules:

<table>
<thead>
<tr>
<th>PS Rules for NPs</th>
<th>PS Rules for Sentences</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP → (D) (A) N</td>
<td>S → NP V</td>
</tr>
<tr>
<td></td>
<td>S → NP V NP</td>
</tr>
</tbody>
</table>
A Technical Problem for our PS Rules:

▶ Our PS rules tell us how sentences can be made from smaller phrases / lexical categories:
  ▶ S \rightarrow NP V
  ▶ S \rightarrow NP V NP
  ▶ NP \rightarrow (D) (A) N

▶ But, they don’t link lexical categories to specific words
  ▶ Nothing in these rules says ‘dog’ is N, or ‘chase’ is V.

▶ So, these rules alone don’t make full English sentences. (Only the ‘skeleton’ of a sentence.)
PS Rules and the ‘Mental Lexicon’

Question:
What can we add so these ‘skeletons’ become full sentences?
PS Rules and the ‘Mental Lexicon’

Question: What can we add so these ‘skeletons’ become full sentences?

Answer: The Mental Lexicon!

Our ‘mental lexicon (dictionary)’ lists for every word:

- How the word is pronounced (it’s phonemic representation)
- What the word means
- The word’s syntactic category (whether it’s a N, V, A, etc.)

A Picture of The Mental Lexicon:

Dog
Sound: /dæg/
Part of Speech: Noun (N)
Meaning: *canis familiaris*

Jump
Sound: /dʒʌmp/
Part of Speech: Verb (V)
Meaning: *to leap*
PS Rules and the ‘Mental Lexicon’

Question: What can we add so these ‘skeletons’ become full sentences?

Answer: The Mental Lexicon!
Our ‘mental lexicon (dictionary)’ lists for every word:

- How the word is pronounced (it’s phonemic representation)
- What the word means
- The word’s syntactic category (whether it’s a N, V, A, etc.)

Key Idea:

- Our mental lexicon can tell us which words can go where in a ‘sentence skeleton’.
- So, the full procedure for making a sentence consults the mental lexicon.
The Procedure for Making Sentences

Step One:
Use the phrase structure rules to make a syntactic tree structure.

\[ S \rightarrow NP \ V \]
\[ NP \rightarrow A \ N \]

```
S
  /\  \\
NP /  V \  \\
  /   \  \\
 A   N  
```
The Procedure for Making Sentences

Step Two:
Go to the mental lexicon; look for words that match the lexical categories in the tree.

Dog
Sound: /dæɡ/
Part of Speech: Noun (N)
Meaning: *canis familiaris*

Jump
Sound: /dʒʌmp/
Part of Speech: Verb (V)
Meaning: *to leap*

Old
Sound: /ɔwld/
Part of Speech: Adjective (A)
Meaning: Advanced in age
The Procedure for Making Sentences

Step Three:
Insert the words with the matching lexical categories under the lexical category labels in the tree

```
S
  /\   \
NP  V
  /   |
A  |  N  jump
  |    |
old  dogs
```
Towards Verb Phrases

- We now have the following, simple rules for sentences:
  - $S \rightarrow NP \, V$
  - $S \rightarrow NP \, V \, NP$

- These two rules don’t cover *all* sentences of English:
Towards Verb Phrases

- We now have the following, simple rules for sentences:
  - $S \rightarrow \text{NP V}$
  - $S \rightarrow \text{NP V NP}$

- These two rules don’t cover *all* sentences of English:

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dog ran <strong>down</strong></td>
<td></td>
</tr>
</tbody>
</table>
Towards Verb Phrases

- We now have the following, simple rules for sentences:
  - S → NP V
  - S → NP V NP

- These two rules don’t cover all sentences of English:

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dog ran down</td>
<td>S → NP V P</td>
</tr>
</tbody>
</table>

The dog chased the cat down

The dog chased the cat down the hill
Towards Verb Phrases

We now have the following, simple rules for sentences:

- S → NP V
- S → NP V NP

These two rules don’t cover all sentences of English:

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dog ran down</td>
<td>S → NP V P</td>
</tr>
<tr>
<td>The dog ran down the hill</td>
<td></td>
</tr>
</tbody>
</table>
Towards Verb Phrases

- We now have the following, simple rules for sentences:
  - $S \rightarrow \text{NP } V$
  - $S \rightarrow \text{NP } V \text{ NP}$

- These two rules don’t cover *all* sentences of English:

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dog ran <em>down</em></td>
<td>$S \rightarrow \text{NP } V \text{ P}$</td>
</tr>
<tr>
<td>The dog ran <em>down the hill</em></td>
<td>$S \rightarrow \text{NP } V \text{ P NP}$</td>
</tr>
</tbody>
</table>
Towards Verb Phrases

- We now have the following, simple rules for sentences:
  - $S \rightarrow NP \ V$
  - $S \rightarrow NP \ V \ NP$

- These two rules don’t cover all sentences of English:

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dog ran down</td>
<td>$S \rightarrow NP \ V \ P$</td>
</tr>
<tr>
<td>The dog ran down the hill</td>
<td>$S \rightarrow NP \ V \ P \ NP$</td>
</tr>
<tr>
<td>The dog chased the cat down</td>
<td></td>
</tr>
</tbody>
</table>
Towards Verb Phrases

- We now have the following, simple rules for sentences:
  - \( S \rightarrow NP \ V \)
  - \( S \rightarrow NP \ V \ NP \)
- These two rules don’t cover all sentences of English:

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dog ran <strong>down</strong></td>
<td>( S \rightarrow NP \ V \ P )</td>
</tr>
<tr>
<td>The dog ran <strong>down the hill</strong></td>
<td>( S \rightarrow NP \ V \ P \ NP )</td>
</tr>
<tr>
<td>The dog chased <strong>the cat down</strong></td>
<td>( S \rightarrow NP \ V \ NP \ P )</td>
</tr>
</tbody>
</table>
Towards Verb Phrases

- We now have the following, simple rules for sentences:
  - $S \rightarrow NP \ V$
  - $S \rightarrow NP \ V \ NP$

- These two rules don’t cover *all* sentences of English:

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dog ran <strong>down</strong></td>
<td>$S \rightarrow NP \ V \ P$</td>
</tr>
<tr>
<td>The dog ran <strong>down the hill</strong></td>
<td>$S \rightarrow NP \ V \ P \ NP$</td>
</tr>
<tr>
<td>The dog chased <strong>the cat down</strong></td>
<td>$S \rightarrow NP \ V \ NP \ P$</td>
</tr>
<tr>
<td>The dog chased <strong>the cat down</strong></td>
<td>$S \rightarrow NP \ V \ NP \ P$</td>
</tr>
</tbody>
</table>

Note: The rules and examples are based on the context of the document.
Towards Verb Phrases

- We now have the following, simple rules for sentences:
  - $S \rightarrow NP \ V$
  - $S \rightarrow NP \ V \ NP$

- These two rules don’t cover *all* sentences of English:

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dog ran down</td>
<td>$S \rightarrow NP \ V \ P$</td>
</tr>
<tr>
<td>The dog ran down the hill</td>
<td>$S \rightarrow NP \ V \ P \ NP$</td>
</tr>
<tr>
<td>The dog chased the cat down</td>
<td>$S \rightarrow NP \ V \ NP \ P$</td>
</tr>
<tr>
<td>The dog chased the cat down</td>
<td>$S \rightarrow NP \ V \ NP \ P \ NP$</td>
</tr>
</tbody>
</table>
Towards Verb Phrases

- We now have the following, simple rules for sentences:
  - \( S \rightarrow \text{NP V} \)
  - \( S \rightarrow \text{NP V NP} \)

- These two rules don’t cover all sentences of English:

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dog ran down</td>
<td>( S \rightarrow \text{NP V P} )</td>
</tr>
<tr>
<td>The dog ran down the hill</td>
<td>( S \rightarrow \text{NP V P NP} )</td>
</tr>
<tr>
<td>The dog chased the cat down</td>
<td>( S \rightarrow \text{NP V NP P} )</td>
</tr>
<tr>
<td>The dog chased the cat down</td>
<td>( S \rightarrow \text{NP V NP P NP} )</td>
</tr>
</tbody>
</table>

Problem:

- Again, all these different rules are getting tedious.
- Again, these separate rules are missing an obvious pattern...
Towards Verb Phrases

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dog ran</td>
<td>S → NP V</td>
</tr>
<tr>
<td>The dog ran down</td>
<td>S → NP V P</td>
</tr>
<tr>
<td>The dog ran down the hill</td>
<td>S → NP V P NP</td>
</tr>
<tr>
<td>The dog chased the cat</td>
<td>S → NP V NP</td>
</tr>
<tr>
<td>The dog chased the cat down</td>
<td>S → NP V NP P</td>
</tr>
<tr>
<td>The dog chased the cat down the hill</td>
<td>S → NP V NP P NP</td>
</tr>
</tbody>
</table>

The Pattern:
All the following combine with NP to make a sentence:

- V
- V P
- V P NP
- V NP
- V NP P
- V NP P NP
## Introducing Verb Phrases

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dog ran</td>
<td>$S \rightarrow \text{NP V}$</td>
</tr>
<tr>
<td>The dog ran down</td>
<td>$S \rightarrow \text{NP V P}$</td>
</tr>
<tr>
<td>The dog ran down the hill</td>
<td>$S \rightarrow \text{NP V P NP}$</td>
</tr>
<tr>
<td>The dog chased the cat</td>
<td>$S \rightarrow \text{NP V NP}$</td>
</tr>
<tr>
<td>The dog chased the cat down</td>
<td>$S \rightarrow \text{NP V NP P}$</td>
</tr>
<tr>
<td>The dog chased the cat down the hill</td>
<td>$S \rightarrow \text{NP V NP P NP}$</td>
</tr>
</tbody>
</table>

### Capturing the Pattern:

English treats all these as ‘the same type of thing’:

- $V$
- $V P$
- $V P NP$
- $V NP$
- $V NP P$
- $V NP P NP$
### Introducing Verb Phrases

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dog ran</td>
<td>$S \rightarrow NP \ V$</td>
</tr>
<tr>
<td>The dog ran down</td>
<td>$S \rightarrow NP \ V \ P$</td>
</tr>
<tr>
<td>The dog ran down the hill</td>
<td>$S \rightarrow NP \ V \ P \ NP$</td>
</tr>
<tr>
<td>The dog chased the cat</td>
<td>$S \rightarrow NP \ V \ NP$</td>
</tr>
<tr>
<td>The dog chased the cat down</td>
<td>$S \rightarrow NP \ V \ NP \ P$</td>
</tr>
<tr>
<td>The dog chased the cat down the hill</td>
<td>$S \rightarrow NP \ V \ NP \ P \ NP$</td>
</tr>
</tbody>
</table>

Capturing the Pattern:

Let’s call this ‘kind of a thing’ a **Verb Phrase (VP)**

(cause there’s always a V in it).

- V
- V P
- V P NP
- V NP
- V NP P
- V NP P NP
## Introducing Verb Phrases

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dog ran</td>
<td>S → NP V</td>
</tr>
<tr>
<td>The dog ran down</td>
<td>S → NP V P</td>
</tr>
<tr>
<td>The dog ran down the hill</td>
<td>S → NP V P NP</td>
</tr>
<tr>
<td>The dog chased the cat</td>
<td>S → NP V NP</td>
</tr>
<tr>
<td>The dog chased the cat down</td>
<td>S → NP V NP P</td>
</tr>
<tr>
<td>The dog chased the cat down the hill</td>
<td>S → NP V NP P NP</td>
</tr>
</tbody>
</table>

Capturing the Pattern:  
We can now use PS rules to state that these are all VPs:

- V
- V P
- V P NP
- V NP
- V NP P
- V NP P NP
## Introducing Verb Phrases

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dog ran</td>
<td>$S \rightarrow NP \ V$</td>
</tr>
<tr>
<td>The dog ran down</td>
<td>$S \rightarrow NP \ V \ P$</td>
</tr>
<tr>
<td>The dog ran down the hill</td>
<td>$S \rightarrow NP \ V \ P \ NP$</td>
</tr>
<tr>
<td>The dog chased the cat</td>
<td>$S \rightarrow NP \ V \ NP$</td>
</tr>
<tr>
<td>The dog chased the cat down</td>
<td>$S \rightarrow NP \ V \ NP \ P$</td>
</tr>
<tr>
<td>The dog chased the cat down the hill</td>
<td>$S \rightarrow NP \ V \ NP \ P \ NP$</td>
</tr>
</tbody>
</table>

**Capturing the Pattern:**

We can now use PS rules to state that these are all VPs:

- $VP \rightarrow V$
- $VP \rightarrow V \ P$
- $VP \rightarrow V \ P \ NP$
- $VP \rightarrow V \ NP$
- $VP \rightarrow V \ NP \ P$
- $VP \rightarrow V \ NP \ P \ NP$
## Introducing Verb Phrases

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dog ran</td>
<td>S → NP V</td>
</tr>
<tr>
<td>The dog ran down</td>
<td>S → NP V P</td>
</tr>
<tr>
<td>The dog ran down the hill</td>
<td>S → NP V P NP</td>
</tr>
<tr>
<td>The dog chased the cat</td>
<td>S → NP V NP</td>
</tr>
<tr>
<td>The dog chased the cat down</td>
<td>S → NP V NP P</td>
</tr>
<tr>
<td>The dog chased the cat down the hill</td>
<td>S → NP V NP P NP</td>
</tr>
</tbody>
</table>

### Capturing the Pattern:
Finally, we can reduce our PS rules for sentences to *just one*:

- VP → V
- VP → V P
- VP → V P NP
- VP → V NP
- VP → V NP P
- VP → V NP P NP
Introducing Verb Phrases

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Rule Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dog ran</td>
<td>S → NP VP</td>
</tr>
<tr>
<td>The dog ran down</td>
<td>S → NP VP</td>
</tr>
<tr>
<td>The dog ran down the hill</td>
<td>S → NP VP</td>
</tr>
<tr>
<td>The dog chased the cat</td>
<td>S → NP VP</td>
</tr>
<tr>
<td>The dog chased the cat down</td>
<td>S → NP VP</td>
</tr>
<tr>
<td>The dog chased the cat down the hill</td>
<td>S → NP VP</td>
</tr>
</tbody>
</table>

Capturing the Pattern:

Finally, we can reduce our PS rules for sentences to *just one*:

- VP → V
- VP → V P
- VP → V P NP
- VP → V NP
- VP → V NP P
- VP → V NP P NP
- S → NP VP
The Basics of Syntax

Course Readings
Introduction
Lexical Categories
Phrase Structure Rules
Introducing Noun Phrases
Some Further Details
Introducing Verb Phrases
Introducing Prepositional Phrases
Summary

Simplifying the VP Rules

Our Phrase Structure Rules:

<table>
<thead>
<tr>
<th>For NPs</th>
<th>For Ss</th>
<th>For VPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP → (D) (A) N</td>
<td>S → NP VP</td>
<td>VP → V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VP → V P</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VP → V P NP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VP → V NP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VP → V NP P</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VP → V NP P NP</td>
</tr>
</tbody>
</table>
Simplifying the VP Rules

Our Phrase Structure Rules:

For NPs
NP \to (D) (A) N

For Ss
S \to NP VP

For VPs
VP \to V
VP \to V P
VP \to V P NP
VP \to V NP
VP \to V NP P
VP \to V NP P NP

Observations:

- Together, these rules for VP say the following:
  - A VP has to have a V in it.
  - A VP can (but need not) have an NP in it
  - A VP can (but need not) have a P in it
  - If a VP has a P in it, it can have another NP after the P
Simplifying the VP Rules

Our Phrase Structure Rules:

For NPs
NP → (D) (A) N

For Ss
S → NP VP

For VPs
VP → V
VP → V P
VP → V P NP
VP → V NP
VP → V NP P
VP → V NP P NP

Observations:

- Together, these rules for VP say the following:
  - A VP has to have a V in it.
  - A VP can (but need not) have an NP in it
  - A VP can (but need not) have a P in it
  - If a VP has a P in it, it can have another NP after the P

- Using parentheses, we can say all this in one rule:
  - VP → V (NP) (P) (NP)
Simplifying the VP Rules

Our Phrase Structure Rules:

For NPs
\[ \text{NP} \rightarrow (D) (A) N \]

For Ss
\[ \text{S} \rightarrow \text{NP} \text{ VP} \]

For VPs
\[ \text{VP} \rightarrow \text{V} (\text{NP}) (P) (\text{NP}) \]

Observations:

- Together, these rules for VP say the following:
  - A VP has to have a V in it.
  - A VP can (but need not) have an NP in it
  - A VP can (but need not) have a P in it
  - If a VP has a P in it, it can have another NP after the P

- Using parentheses, we can say all this in one rule:
  \[ \text{VP} \rightarrow \text{V} (\text{NP}) (P) (\text{NP}) \]
Simplifying the VP Rules

Our Phrase Structure Rules:

For NPs
NP → (D) (A) N

For Ss
S → NP VP

For VPs
VP → V (NP) (P) (NP)

▶ These three rules work together with the mental lexicon to create rather complex sentences of English.

Dave fell down.
Simplifying the VP Rules

Our Phrase Structure Rules:

For NPs
NP → (D) (A) N

For Ss
S → NP VP

For VPs
VP → V (NP) (P) (NP)

▶ These three rules work together with the mental lexicon to create rather complex sentences of English.

```
S
  NP
    N
    Dave
  VP
    V
    fell
    P
    down
```

“Dave fell down.”
Simplifying the VP Rules

Our Phrase Structure Rules:

For NPs
\[ NP \to (D) (A) N \]

For Ss
\[ S \to NP \ VP \]

For VPs
\[ VP \to V (NP) (P) (NP) \]

- These three rules work together with the mental lexicon to create rather complex sentences of English.

```
S
  \|-- NP
     \|-- A
        |  \|-- N
          \|-- cars
  \|-- VP
     \|-- V
        |  \|-- NP
          \|-- D
             |  \|-- N
                \|-- this
                \|-- food
```

“Ugly cats like this food.”
Simplifying the VP Rules

Our Phrase Structure Rules:

For NPs:
\[ NP \rightarrow (D) (A) N \]

For Ss:
\[ S \rightarrow NP \ VP \]

For VPs:
\[ VP \rightarrow V (NP) (P) (NP) \]

These three rules work together with the mental lexicon to create rather complex sentences of English.

```
S
  NP
    D A N V NP P NP
       the old man put A N into D A N
                      broken cups a wooden box
```

“The old man put broken cups into a wooden box.”
Towards Prepositional Phrases

Fun Fact: Prepositions can also appear inside NPs!

- The boy **in** the yard jumped.
- The dog **outside** the fence barked.
- The dog **outside** barked.
Towards Prepositional Phrases

Fun Fact: Prepositions can also appear inside NPs!

- The boy **in** the yard jumped.
- The dog **outside** the fence barked.
- The dog **outside** barked.

Neded Change to PS Rules: $\text{NP} \rightarrow (D) (A) N (P) (NP)$
Towards Prepositional Phrases

Our Phrase Structure Rules:

<table>
<thead>
<tr>
<th>For NPs</th>
<th>For Ss</th>
<th>For VPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP → (D) (A) N (P) (NP)</td>
<td>S → NP VP</td>
<td>VP → V (NP) (P) (NP)</td>
</tr>
</tbody>
</table>

Apparent Pattern:
Wherever English allows P, it also allows P followed by NP

Illustration:
- The dog outside barked
- The dog outside the fence barked.
- The dog climbed down the tree.
Towards Prepositional Phrases

Our Phrase Structure Rules:

For NPs
NP → (D) (A) N (P) (NP)

For Ss
S → NP VP

For VPs
VP → V (NP) (P) (NP)

Apparent Pattern:
Wherever English allows P, it also allows P followed by NP
## Towards Prepositional Phrases

**Our Phrase Structure Rules:**

<table>
<thead>
<tr>
<th>For NPs</th>
<th>For Ss</th>
<th>For VPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP $\rightarrow$ (D) (A) N (P) (NP)</td>
<td>S $\rightarrow$ NP VP</td>
<td>VP $\rightarrow$ V (NP) (P) (NP)</td>
</tr>
</tbody>
</table>

**Apparent Pattern:**
Wherever English allows P, it also allows P followed by NP

**Illustration:**

- The dog **outside** barked
  The dog **outside the fence** barked.

- The dog climbed **down**
  The dog climbed **down the tree**.
Introducing Prepositional Phrases

Our Phrase Structure Rules:

<table>
<thead>
<tr>
<th>For NPs</th>
<th>For Ss</th>
<th>For VPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP → (D) (A) N (P) (NP)</td>
<td>S → NP VP</td>
<td>VP → V (NP) (P) (NP)</td>
</tr>
</tbody>
</table>

Apparent Pattern:
Wherever English allows P, it also allows P followed by NP

Capturing the Pattern:
English treats ‘P’ and ‘P NP’ as the same ‘type’ of thing.
Introducing Prepositional Phrases

Our Phrase Structure Rules:

- **For NPs**
  \[ NP \rightarrow (D) (A) N (P) (NP) \]

- **For Ss**
  \[ S \rightarrow NP \ VP \]

- **For VPs**
  \[ VP \rightarrow V (NP) (P) (NP) \]

**Apparent Pattern:**
Wherever English allows P, it also allows P followed by NP

**Capturing the Pattern:**
Let’s call this type of thing a ‘Propositional Phrase’ (PP) (since there’s always a P in it).
Introducing Prepositional Phrases

Our Phrase Structure Rules:

For NPs
NP → (D) (A) N (P) (NP)

For Ss
S → NP VP

For VPs
VP → V (NP) (P) (NP)

Apparent Pattern:
Wherever English allows P, it also allows P followed by NP

Capturing the Pattern:
These rules let us say PP is either P or P followed by NP:

▶ PP → P
▶ PP → P NP
Introducing Prepositional Phrases

Our Phrase Structure Rules:

For NPs
NP → (D) (A) N (P) (NP)

For Ss
S → NP VP

For VPs
VP → V (NP) (P) (NP)

Apparent Pattern:
Wherever English allows P, it also allows P followed by NP

Capturing the Pattern:
Using parentheses, these rules can be condensed into one:

- PP → P
- PP → P NP
Introducing Prepositional Phrases

Our Phrase Structure Rules:

For NPs
NP → (D) (A) N (P) (NP)

For Ss
S → NP VP

For VPs
VP → V (NP) (P) (NP)

Apparent Pattern:
Wherever English allows P, it also allows P followed by NP

Capturing the Pattern:
Using parentheses, these rules can be condensed into one:

▶ PP → P (NP)
   (a PP must have P, and can optionally have NP after P)
Introducing Prepositional Phrases

Our Phrase Structure Rules:

**For NPs**

NP → (D) (A) N (PP)

**For Ss**

S → NP VP

**For VPs**

VP → V (NP) (PP)

**For PPs**

PP → P (NP)

Apparent Pattern:
Wherever English allows P, it also allows P followed by NP

Capturing the Pattern:
Using parentheses, these rules can be condensed into one:

- PP → P (NP)
  (a PP must have P, and can optionally have NP after P)
Introducing Prepositional Phrases

Our Four Phrase Structure Rules:

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

These 4 rules can create very complex sentences of English.
Introducing Prepositional Phrases

Our Four Phrase Structure Rules:

- $S \rightarrow NP \ VP$
- $NP \rightarrow (D) \ (A) \ N \ (PP)$
- $VP \rightarrow V \ (NP) \ (PP)$
- $PP \rightarrow P \ (NP)$

These 4 rules can create very complex sentences of English.
Syntax = (the study of) the rules of sentence formation

- These rules give a general recipe for making sentences.
- They don’t mention specific words (‘cat’, ‘jump’, ‘dog’)
- Instead, they mention categories of words
Summary

- **Syntax** = (the study of) the rules of sentence formation
  - These rules give a general recipe for making sentences.
  - They don’t mention specific words (‘cat’, ‘jump’, ‘dog’)
  - Instead, they mention *categories* of words

- **Syntactic category** =
  the word-categories that the rules of syntax refer to.
  - Noun (N)  dog, cat, table, happiness...
  - Verb (V)  jump, sleep, love, think...
  - Adjective (A)  tall, ugly, dead, uncool...
  - Determiner (D)  the, a, this, many, most...
  - Preposition (P)  in, on, to, with, for...
Summary

- Sentences are not just strings of words.
- They have a complex internal structure:
  - Sentences are made out of *phrases*: NPs and VPs.
  - NPs are made out of Ds, As, Ns, and PPs
  - VPs are made out of Vs, NPs and PPs
  - PPs are made out of Ps and NPs
The Basics of Syntax

Introduction

Lexical Categories

Phrase Structure Rules

Introducing Noun Phrases

Some Further Details

Introducing Verb Phrases

Introducing Prepositional Phrases

Summary

► Sentences are not just strings of words.
► They have a complex internal structure:
  ▶ Sentences are made out of *phrases*: NPs and VPs.
  ▶ NPs are made out of Ds, As, Ns, and PPs
  ▶ VPs are made out of Vs, NPs and PPs
  ▶ PPs are made out of Ps and NPs

► We can express these groupings with ‘Phrase Structure (PS) Rules’:
  ▶ S → NP VP
  ▶ NP → (D) (A) N (PP)
  ▶ VP → V (NP) (PP)
  ▶ PP → P (NP)
Summary

Our Four Phrase Structure Rules:

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

Our Four Phrase Structure Rules:

\[ S \to \text{NP} \ \text{VP} \]
\[ \text{NP} \to (D) \ (A) \ N \ (PP) \]
\[ \text{VP} \to V \ (NP) \ (PP) \]
\[ \text{PP} \to P \ (NP) \]

Our linguistic systems make sentences by using these PS rules and our ‘mental lexicon’:
Summary

Our Four Phrase Structure Rules:

S → NP VP
NP → (D) (A) N (PP)
VP → V (NP) (PP)
PP → P (NP)

Our linguistic systems make sentences by using these PS rules and our ‘mental lexicon’:

▶ **Step One:** Use PS rules to make a tree structure.

[Diagram of tree structure]
Summary

Our Four Phrase Structure Rules:

\[
S \rightarrow \text{NP VP}
\]
\[
\text{NP} \rightarrow (\text{D}) \ (\text{A}) \ \text{N} \ (\text{PP})
\]
\[
\text{VP} \rightarrow \text{V} \ (\text{NP}) \ (\text{PP})
\]
\[
\text{PP} \rightarrow \text{P} \ (\text{NP})
\]

Our linguistic systems make sentences by using these PS rules and our ‘mental lexicon’:

▶ **Step Two:** Find words in mental lexicon that match categories in tree.
Summary

Our Four Phrase Structure Rules:

\[
S \rightarrow \text{NP} \ \text{VP} \\
\text{NP} \rightarrow (\text{D}) \ (\text{A}) \ \text{N} \ (\text{PP}) \\
\text{VP} \rightarrow \text{V} \ (\text{NP}) \ (\text{PP}) \\
\text{PP} \rightarrow \text{P} \ (\text{NP})
\]

Our linguistic systems make sentences by using these PS rules and our ‘mental lexicon’:

▶ **Step Two:**
Find words in mental lexicon that match categories in tree.

- A = ‘angry’
- N = ‘bees’
- V = ‘sting’
- P = ‘on’
- D = ‘the’
- N = ‘face’
Summary

Our Four Phrase Structure Rules:

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

Our linguistic systems make sentences by using these PS rules and our ‘mental lexicon’:

- **Step Three:**
  - Insert those words into the tree structure, under the appropriate category labels.
  - A = ‘angry’
  - N = ‘bees’
  - V = ‘sting’
  - P = ‘on’
  - D = ‘the’
  - N = ‘face’
Summary

Our Four Phrase Structure Rules:

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

Our linguistic systems make sentences by using these PS rules and our ‘mental lexicon’:

▶ Step Three:

```
S
   /\  \\
 NP  VP
   /  \\
 A   N  V
   /   \\
Angry bees sting
   /    \\
               P
               /  \\
              on  NP
              /  \\
             the  N
             /  \\
            the  face
```