Phrase Structure

A formal hypothesis for representing constituency
Constituents are hierarchically organized

The man eats at fancy restaurants.

[TP [NP [D the] [N man]] [VP [V eats] [PP [P at] [NP [AdjP [Adj fancy]] [N restaurants]]]]]
Phrase Structure Rules

- Rules to represent hierarchical structure

eg. $TP \rightarrow NP \; VP$

```
  TP
 /\  \
NP  VP
```
Rules to represent hierarchical structure

eg. $TP \rightarrow NP \ VP$

constituent

\begin{tikzpicture}
  \node (TP) {TP};
  \node (NP) [below left of=TP] {NP};
  \node (VP) [below right of=TP] {VP};
  \draw (TP) -- (NP);
  \draw (TP) -- (VP);
\end{tikzpicture}
Phrase Structure Rules

Rules to represent hierarchical structure

eg. $TP \rightarrow NP \; VP$

constituent

(sub)constituents
Phrase Structure Rules

\[ \text{XP} \rightarrow (\text{YP}) \times (\text{ZP}+) \]
Phrase Structure Rules

\[ XP \rightarrow (YP) \ X \ (ZP+) \]

X, Y, Z are variables representing any category (e.g., N, V, A, P, etc.)
Phrase Structure Rules

XP \to (YP) \ X \ (ZP+)

the name of
the
constituent

X, Y, Z are variables representing any category (e.g., N, V, A, P, etc.)
Phrase Structure Rules

XP \rightarrow (YP) X (ZP+)

the name of the constituent

“consists of”

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XP \rightarrow (YP) X (ZP+)

the name of the constituent

“consists of”

elements inside of constituent IN ORDER from Left to Right

X, Y, Z are variables representing any category (e.g., N, V, A, P, etc.)
Phrase Structure Rules

XP $\rightarrow (YP) \ X \ (ZP+)$

- The name of the constituent
- "consists of"
- Elements inside of constituent IN ORDER from Left to Right

X, Y, Z are variables representing any category (e.g., N, V, A, P, etc.)
Phrase Structure Rules

XP \rightarrow (YP) X (ZP+)

- the name of the constituent
- "consists of"
- elements without parentheses are obligatory
- elements in parentheses are optional
- elements inside of constituent IN ORDER from Left to Right

X, Y, Z are variables representing any category (e.g., N, V, A, P, etc.)
Phrase Structure Rules

XP → (YP) X (ZP+)

+ means you can have as many as you need

elements in parentheses are optional

elements without parentheses are obligatory

"consists of"

elements inside of constituent IN ORDER from Left to Right

X, Y, Z are variables representing any category (e.g., N, V, A, P, etc.)

the name of the constituent

"consists of"

the name of
This will be our first case study:
- We will propose a rule,
- Test it against evidence, and repeatedly revise it until we get a more adequate picture of what the rule is.
- Along the way, we’ll be practicing tree structure diagrams, both creating them and reading them.
- We’ll then extend the analysis of NPs to other phrases.
Questions to Ask:

1. What *must occur* in an NP?

2. What is *optional* in an NP? (Notation: inside parentheses)

3. What can *repeat* in an NP? (Notation: +)

4. What is the *relative order* of these elements?
Noun Phrases (NP)

- A noun phrase can be just a bare noun:
Noun Phrases (NP)

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$\text{[NP John]}$ left (cf. $\text{[NP the man]}$ left)
A noun phrase can be just a bare noun:

- \[\text{NP John}\] left (cf. \[\text{NP the man}\] left)
  
  - So all other material other than the Noun itself will be optional.
A noun phrase can be just a bare noun:

- \([\text{NP} \text{ John}] \text{ left} \) (cf. \([\text{NP} \text{ the man}] \text{ left}\))
  - *So all other material other than the Noun itself will be optional.*

- The N in an NP is called the **Head** of the NP, (usually the head is the only obligatory part of a phrase -- there are some exceptions)
Noun Phrases (NP)

- A noun phrase can be just a bare noun:
  - \([_{NP}\text{ John}]\text{ left} \) (cf. \([_{NP}\text{ the man}]\text{ left}\))
  - So all other material other than the Noun itself will be optional.
- The N in an NP is called the Head of the NP, (usually the head is the only obligatory part of a phrase -- there are some exceptions)
- NP \(\rightarrow\) N
Noun Phrases (NP)

- A noun phrase can be just a bare noun:
  - [NP John] left (cf. [NP the man] left)
  - So all other material other than the Noun itself will be optional.

- The N in an NP is called the **Head** of the NP, (usually the head is the only obligatory part of a phrase -- there are some exceptions)

- NP → N

```
  NP
   |
   N
  John
```
Let’s make sure that the N is really obligatory:

*The are really valuable
*Very old are really valuable
*Very old from France are really valuable
Noun Phrases (NP)
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- NPs can have an optional determiner and adjective phrases.
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- You are allowed one determiner and as many AdjPs as you like:
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  - [slippers]
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    - [the slippers]
    - [pink slippers]
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  - [the pink slippers]
  - [pink fluffy slippers]
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- [the slippers]
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- [the pink slippers]
- [pink fluffy slippers]
- [the pink fluffy slippers]
- *the a slippers
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    - [pink slippers]
    - [the pink slippers]
    - [pink fluffy slippers]
    - [the pink fluffy slippers]
    - *the a slippers

\[ \text{NP} \rightarrow (D) \ (\text{AdjP}+) \ N \]
Noun Phrases (NP)

NP → (D) (AdjP+) N

NP

D     AdjP   AdjP   N
the   A       A       slippers
  pink  fluffy
Noun Phrases (NP)
NPs also allow as many optional PPs following the N as you like:

- The book of poems
- The book of poems with the red cover
- The book of poems with the red cover from New York
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NP → (D) (AdjP+) N (PP+)
Noun Phrases (NP)

NPs can also be modified by clauses (CPs):
- The fact [that I like haggis]
- The book of poems with the red cover [that I bought in NYC]
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- The fact [that I like haggis]
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NP → (D) (AdjP+) N (PP+) (CP)
Noun Phrases (NP)
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NP $\rightarrow$ (D) (AdjP+) N (PP+) (CP)
Noun Phrases (NP)

NP \rightarrow (D) (AdjP+) N (PP+) (CP)

“NP consist of”
Noun Phrases (NP)

NP $\rightarrow$ (D) (AdjP+) N (PP+) (CP)

“NP consist of”

“an optional determiner” (brackets mean optional)
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“followed by any number of optional Adjective Phrases” (+= any number of)
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“followed by a noun” (the head.)

“followed by any number of optional Adjective Phrases” (+= any number of)
Noun Phrases (NP)

- NP \rightarrow (D) (AdjP+) N (PP+) (CP)

  - "NP consist of"
  - "an optional determiner" (brackets mean optional)
  - "followed by any number of optional Adjective Phrases" (+= any number of)
  - "followed by a noun" (the head.)
  - "followed by any number of optional Prepositional phrases"
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NP → (D) (AdjP+) N (PP+) (CP)

“NP consist of”

“an optional determiner” (brackets mean optional)

“followed by any number of optional Adjective Phrases” (+= any number of)

“followed by any number of optional Prepositional phrases”

“followed by a noun” (the head)

“Followed by an optional CP”
Noun Phrases (NP)

NP \rightarrow (\text{det}) \ (\text{AdjP+}) \ N \ (\text{PP+}) \ (\text{CP})

\[
\text{NP} \quad \text{det} \quad \text{AdjP} \quad \text{AdjP} \quad \text{N} \quad \text{PP} \\
\quad \text{the} \quad \quad \quad \quad \quad \text{book} \\
\quad \quad \text{Adj} \quad \text{Adj} \\
\quad \text{big} \quad \text{yellow} \\
\quad \quad \text{P} \quad \text{NP} \\
\quad \quad \quad \text{of} \quad \text{N} \\
\quad \quad \quad \quad \quad \text{poems}
\]
Adjective Phrases and Adverb Phrases

- Adjectives and Adverbs can stand on their own as phrases:
  - the [red] lipstick
  - AdjP → Adj
  - John left quickly
  - AdvP → Adv
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- Adjectives and Adverbs can stand on their own as phrases:
  - the [red] lipstick  
  - AdjP $\rightarrow$ Adj
  - John left quickly  
  - AdvP $\rightarrow$ Adv

- But they can also be modified by AdvPs:
  - John left [rather quickly]
  - the [very red] lipstick
  - AdjP $\rightarrow$ (AdvP) Adj
  - AdvP $\rightarrow$ (AdvP) Adj
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```
AdvP
  /   /
AdvP Adv
       |
   quickly
       |
Adv
       |
rather
```
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  - AdvP → (AdvP) Adj

```
AdvP       Adv
     |       |
     AdvP   Adv
       |       |
       Adv   Adv
   AdjP       Adj
       |       |
       Adv   Adv
     rather   very
```
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  - AdvP → (AdvP) Adj

\[
\begin{align*}
\text{AdjP} & \rightarrow \text{Adj} \\
\text{AdvP} & \rightarrow \text{Adv}
\end{align*}
\]
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But they can also be modified by AdvPs:
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- AdjP → (AdvP) Adj
- AdvP → (AdvP) Adj
Adjective/Adverb Phrases (APs)
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- A situation easily confused:
  - The big yellow balloon
  - The very yellow balloon

- What does ‘big’ modify? What does ‘very’ modify?
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  - The very yellow balloon

- What does ‘big’ modify? What does ‘very’ modify?
The Principle of Modification
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If an XP modifies some head Y, then XP must be Y’s sister.
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Prepositional Phrases (PPs)
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These generally consist of a Preposition and an NP:
- up the road
- on the video screen
- under the avocado
- PP→P NP
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- up the road
- on the video screen
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- PP → P NP

```
PP
   P     NP
     under
       D   N
         the   avocado
```
Prepositional Phrases (PPs)
**Prepositional Phrases (PPs)**

Is the NP in a PP optional?
- I threw the garbage **out**
- The construction workers blew the building **up**
- I haven’t seen him **before**
- PP $\rightarrow$ P (NP)
Prepositional Phrases (PPs)

- Is the NP in a PP optional?
  - I threw the garbage *out*
  - The construction workers blew the building *up*
  - I haven’t seen him *before*
  - PP → P (NP)

- This is controversial: not everyone agrees these are prepositions.
Verb Phrases (VP)
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Verbs by themselves:

- Marko [arrived]
- Susan [sang]
- VP → V
Verb Phrases (VP)

- Verbs by themselves:
  - Marko [arrived]
  - Susan [sang]
  - VP $\rightarrow$ V

- Verbs can be modified by adverbs:
  - Marko [often sang]
  - Susan [sang beautifully]
  - Luis [often sang beautifully]
  - VP $\rightarrow$ (AdvP+) V (AdvP+)

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Verb Phrases (VP)
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Verbs modified by PPs:
- Marko sang [though a microphone]
- Susan sang [to her parents] beautifully
- Susan sang beautifully [to her parents]
- \[\text{VP} \rightarrow (\text{AdvP}+) \text{ V} (\text{AdvP}+) (\text{PP}+) (\text{AdvP}+)\]
Verb Phrases (VP)

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- Verbs with an NP object:
  - Marko sang [a song] to his parents beautifully
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- Verbs with an NP object:
  - Marko sang [a song] to his parents beautifully
  - VP $\rightarrow$ (AdvP+) V (NP) (AdvP+) (PP+) (AdvP+)

- Verbs with an NP object and NP indirect object:
  - Marko sent [his parents] [a package].
  - VP $\rightarrow$ (AdvP+) V (NP) (NP) (AdvP+) (PP+) (AdvP+)
Verb Phrases (VP)

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  - Marko sang [though a microphone]
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- Verbs with an NP object:
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- Verbs with an NP object and NP indirect object:
  - Marko sent [his parents] [a package].
  - $\text{VP} \rightarrow (\text{AdvP}+) \ V \ (\text{NP}) \ (\text{NP}) \ (\text{AdvP}+) \ (\text{PP}+) \ (\text{AdvP}+)$

- Verbs with a Sentence (CP) Object:
  - Fred said [Marko sang a song] with some derision yesterday
  - Fred asked Bill [if his T-shirt was inappropriate]
  - $\text{VP} \rightarrow (\text{AdvP}+) \ V \ (\text{NP}) \ (\{\text{NP/CP}\}) \ (\text{PP}+) \ (\text{AdvP}+)$
Verb Phrases (VP)

VP \rightarrow (AdvP+) \ V \ (NP)\{(NP/CP)\}(AdvP) \ (PP+) \ (AdvP+)

\[
\begin{align*}
\text{AdvP} & \quad \text{V} & \quad \text{NP} & \quad \text{PP} & \quad \text{PP} \\
\text{Adv} & \quad \text{got} & \quad \text{D} \quad \text{N} & \quad \text{P} \quad \text{NP} & \quad \text{P} \quad \text{NP} \\
\text{frequently} & \quad \text{his} \quad \text{buckets} & \quad \text{from} & \quad \text{for} & \quad \text{the} \quad \text{store} & \quad \text{a} \quad \text{dollar}
\end{align*}
\]
TPs (tense phrases)
Sentences consist of a subject (NP) and a predicate (VP). In English, neither is optional (although in other languages the subject may be omitted).
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- TP → NP VP
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Clauses (Sentences)
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- Sentences may have an optional auxiliary or modal verb (of the Category T)
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- $TP \rightarrow NP \ (T) \ VP$
Clauses (Sentences)

- Sentences may have an optional auxiliary or modal verb (of the Category T)
- TP \(\rightarrow\) NP (T) VP

```
NP  T  VP
  NP  |  VP
    Traci | will  eat
          | the   N
          | pizza
```
Sometimes clauses can function as the subject or object of other clauses.

- I asked [if Maria would eat the spaghetti]
- I think [that Maria decked the Janitor]
- [That Maria decked the Janitor] is obvious
**Embedded Clauses**

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  - I asked [if Maria would eat the spaghetti]
  - I think [that Maria decked the Janitor]
  - [That Maria decked the Janitor] is obvious

- Words like “that” and “if” are called complementizers.
  - CP → (Comp) TP
Embedded Clauses

- $\text{VP} \rightarrow (\text{AdvP}+) \ V \ (\{\text{NP}/\text{CP}\}) \ (\text{PP}+) \ (\text{AP}+)$

- $\text{TP} \rightarrow \{\text{NP}/\text{CP}\} \ (T) \ \text{VP}$
the syntactician think that the phonologist said the sentence
A common mistake

Note the structure of the following three simplified rules (I’ve left out the material that isn’t relevant to the point I’m making):

- VP → V (CP)
- TP → NP (T) VP
- CP → (Comp) TP

- VP is only ever a mother to CP’ (never TP), and CP’ is only ever a mother to Comp and TP (never NP nor VP)
So with the following rules, you can draw only certain trees:

- $VP \rightarrow V \ (CP)$
- $TP \rightarrow NP \ (T) \ VP$
- $CP \rightarrow \ (Comp) \ TP$

A common mistake
A common mistake

So with the following rules, you can draw only certain trees:

- $VP \rightarrow V \ (CP)$
- $TP \rightarrow NP \ (T) \ VP$
- $CP \rightarrow (Comp) \ TP$

Bill said that Mary left
A common mistake

Note that the rules require BOTH the CP and TP even if there is no complementizer

- VP $\rightarrow$ V (CP)
- TP $\rightarrow$ NP (T) VP
- CP $\rightarrow$ (Comp) TP

Bill said Mary left

*
A common mistake

- Note that the rules require BOTH the CP and TP even if there is no complementizer
  - $VP \rightarrow V \ (CP)$
  - $TP \rightarrow NP \ (T) \ VP$
  - $CP \rightarrow (\text{Comp}) \ TP$

Bill said Mary left

- *No rule says $CP \rightarrow NP \ VP$*
Note that the rules require BOTH the CP and TP even if there is no complementizer.

- VP → V (CP)
- TP → NP (T) VP
- CP → (Comp) TP

Bill said Mary left

- No rule says CP → NP VP
Note that the rules require BOTH the CP and TP even if there is no complementizer:

- VP → V (CP)
- TP → NP (T) VP
- CP → (Comp) TP

Bill said Mary left

A common mistake
A common mistake

Note that the rules require BOTH the CP and TP even if there is no complementizer:

- \( VP \rightarrow V \ (CP) \)
- \( TP \rightarrow NP \ (T) \ VP \)
- \( CP \rightarrow (Comp) \ TP \)

Bill said Mary left

No rule says \( VP \rightarrow V \ (TP) \)
Note that the rules require BOTH the CP and TP even if there is no complementizer.

- VP → V (CP)
- TP → NP (T) VP
- CP → (Comp) TP

Bill said Mary left

No rule says VP → V (TP)
An obvious but important point

- Your trees and your rules must correspond to one another.

- When you are drawing your trees (we’ll do a lot of practice in a week or so) you must make sure that the tree is consistent with the rules.
Recursion
Recursion

- Language is infinite: you can say sentences that have never been said before.
Recursion

- Language is infinite: you can say sentences that have never been said before.
- \( NP \rightarrow N \quad PP \)
Recursion

- Language is infinite: you can say sentences that have never been said before.
- NP $\rightarrow$ N PP
- PP $\rightarrow$ P NP
Recursion

- Language is infinite: you can say sentences that have never been said before.
- NP $\rightarrow$ N PP
- PP $\rightarrow$ P NP
Language is infinite: you can say sentences that have never been said before.

NP → N PP
PP → P NP
Recursion

- Language is infinite: you can say sentences that have never been said before.

- \[ NP \rightarrow N \quad PP \]
- \[ PP \rightarrow P \quad NP \]

```
NP
  N
  PP
  P
  NP
  P
  NP
  etc!!!!
```
Recursion

Language is infinite: you can say sentences that have never been said before.

This property is called **Recursion**
Constituency & hierarchical structure is captured by phrase structure rules (PSRs)
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These rules also capture the recursive (infinite) property of language.
PSRs of English

- CP $\rightarrow$ (C) TP
- TP $\rightarrow$ \{NP/CP\} (T) VP
- VP $\rightarrow$ (AdvP+) V (NP)\{NP/CP\} (AdvP+) (PP+) (AdvP+)
- NP $\rightarrow$ (D) (AdjP+) N (PP+) (CP)
- PP $\rightarrow$ P (NP)
- AdjP $\rightarrow$ (AdvP) Adj
- AdvP $\rightarrow$ (AdvP) Adv
PSRs of English

cp \rightarrow (C) TP

tp \rightarrow \{NP/CP\} (T) VP

vp \rightarrow (AdvP+) V (NP)({NP/CP}) (AdvP+) (PP+) (AdvP+)

np \rightarrow (D) (AdjP+) N (PP+) (CP)

pp \rightarrow P (NP)

adjp \rightarrow (AdvP) Adj

advp \rightarrow (AdvP) Adv

to be significantly revised