Introduction to Language

Derek Denis

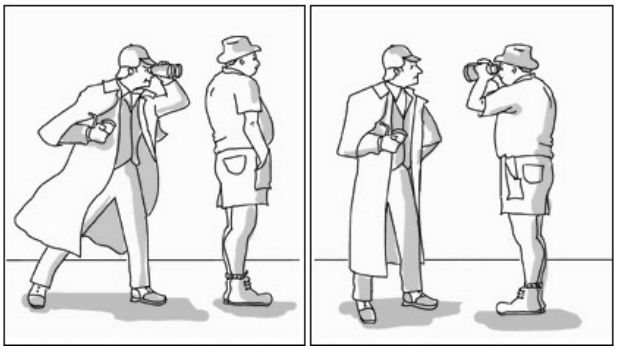
University of Toronto
derek.denis@mail.utoronto.ca

Lecture 5: Oct. 8 2013

Road Map

1. What's syntax and why it needs abstract generalization.
2. Grammatical Categories
   - Description of them.
   - Using morphology and syntactic templates to identify them.
   - Exercise: Jabberwocky
3. Generative Rules and Syntactic Structure
   - Three core properties of human language syntax.
   - Syntactic Phrases
   - Syntactic Tree Structures
   - Structural Ambiguity

Sherlock saw the man with binoculars.



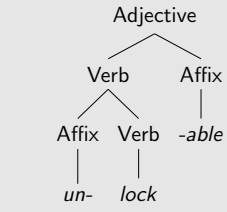
This sentence is **ambiguous**. Why?

Sherlock saw the man with binoculars.

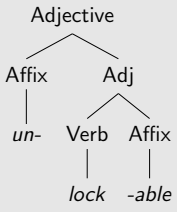
This sentence is **structurally ambiguous**, just like *unlockable* is structurally ambiguous.

- Two different structures, two different interpretations.

'able to be unlocked'



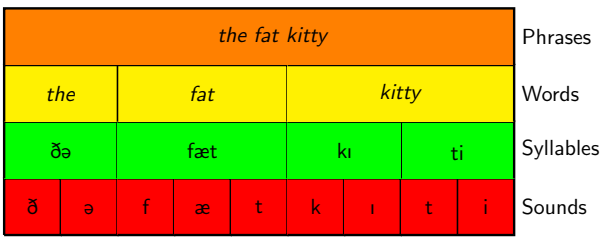
'not able to be locked'



Syntax

So far in this course we've seen that all languages are composed of **sounds** that form **syllables** that form **morphemes** that form **words**. Today we're going to see how languages combine words to form phrases and sentences.

... ...



Syntax

Syntax is the study of **sentence formation and structure**.

- Attempt to make generalizations about how words combine.

1. What is the structure of a sentence?
   - What are its parts? How do they get put together?
2. Why can a sentence be infinitely long?
3. How do other languages differ with respect to syntactic structure?

Why syntax requires abstract generalization

We've seen that...

- There are a finite number of sounds in every language.
  - Just under 40 **phonemes** in most English dialects.

We know that...

- There are lists of (nearly) all the words of a language.
  - About 250 000 in the Oxford English Dictionary
  - A finite number of morphemes in a language (though mostly an open class).

So should syntacticians come up with a list of all the sentences in a language?

Good luck!!

Why syntax requires abstract generalization

An infinite number of sentences

- The number of sentences that any given individual is capable of would easily be in the **billions**.
  - The majority of sentences we hear are ones we've never heard before.
- In fact, because of a property of human language syntax called recursion, there are actually an **infinite** number of sentences in any given language.

Why syntax requires abstract generalization

Memorizing sentences isn't how we understand and use language

- If we encounter a new word in our daily lives, we might consult a dictionary and read the definition. We'll probably memorize it, but we might forget it if we don't use it or hear it often.
- But we don't memorize or learn sentences.
  - You have no problem understanding brand new sentences you've never encountered before.
  - You're able to produce sentences that you've never encountered before.

Why syntax requires abstract generalization

There are predictable patterns

The way words are combined to form sentences **isn't random**.

- If you want to create a two word sentence in English, words in set A, will always come before words in set B.
  - **Set A**: {*Lucy*, *Sue*, *Mary*}
  - **Set B**: {*walked*, *smiled*, *ran*}
  - *Mary walked.... Sue smiled.... Lucy ran....*
  - **Walked Mary.... *Smiled Sue.... *Ran Lucy....*

Grammatical Categories

Grammatical Categories

Last week, we saw that words of a language are classified into **grammatical categories**.

- A concept dating back to early linguistics.
- Yāska, a Sanskrit grammarian, first recognized the distinction between **nouns** (*nāma*) and **verbs** (*ākhyāta*).

In elementary school you likely learned about:

-nouns
-verbs
-adjectives
-adverbs
-prepositions
-interjections
-conjunctions

grammatical categories
= word classes
= parts of speech

The Elementary School Description

Nouns
- Person
- Place
- Thing
- ...

Verbs
- Action
- Events
- States of being
- ...

Adjectives
- quality
- quantity
- extent
- ...

Meaning-based approaches to grammatical categories can be helpful but should be approached with extreme caution.

Problems With The Elementary School Description

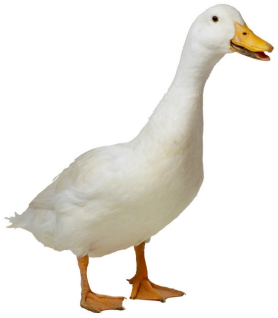
Meaning distinctions are not clear-cut:
- The **wedding** of Will and Kate.
  - Noun describing an event.
- **Honesty** is the best policy.
  - An abstract concept, neither a person, place nor thing.

The same word can have multiple grammatical categories
- We **work** at the factory. A verb.
- This **work** is hard A noun.
- She bought **work** clothes. An adjective.

Nonsense words (without a meaning) have clear grammatical categories within a sentence.

The yinkish dripner blorked quastofically into the nindin with the pidibs.

How to identify grammatical categories



Basically...
- "If it walks like a duck and quacks like a duck, it's probably a duck."
- If it acts like a noun(verb, adjective, preposition...) then it probably is a noun(verb, adjective, preposition...).

How to identify grammatical categories

So how does a noun/verb/adjective/preposition/etc. act?

The best way is to use **distributional criteria**.
- **Morphological criteria**
  - Some morphological affixes can only attach to words of certain grammatical category.
  - We can say **smile-ed** and **talk-ed** but not ***desk-ed** or ***toward-ed**.
- **Syntactic criteria**
  - Only certain kinds of words can be put in **syntactic frames** and form grammatical sentences.
  - We can say [the **man** left] but not *[the **red** left] or *[the **talk** left].

Different languages have different distributional criteria!

Grammatical Categories in Syntax

Syntacticians make use of the following grammatical categories in analyzing the syntactic structure of languages.:
- Nouns
- Verbs
- Adjectives
- Adverbs
- Determiners
- Complementizers
- Conjunctions
- Prepositions

How can we identify each?

Identifying nouns

Morphological Criteria

Recall that there is one **inflectional affix** that attaches to nouns in English: the plural morpheme **-s**.
- If a word can occur with the plural morpheme, it's probably a noun.
  - **cat/cats, hand/hands, gender/genders, party/parties**
- If a word cannot occur with the plural morpheme, it might not be a noun.
  - **terribly/*terriblies, that/*thats, some/*somes, tall/*talls**

⋆ ⋆ ⋆ Don't be confused by the other inflectional affix *-s* that attaches to verbs. ⋆ ⋆ ⋆
- run/run-$s_{[3rd\ person,\ singular\ agreement]}$
- But... *run-$s_{[plural]}$ can't mean "run twice".

Identifying nouns

There are also several **derivational affixes** that attach to other grammatical categories and can result in nouns.

all nouns!!
- *entertain*-**ment**
- *happi*-**ness**
- *pur*-**ity**
- *democratiz*-**ation**
- *anarch*-**ist**
- *green*-**ery**
- *employ*-**ee**
- *friend*-**ship**
- *million*-**aire**
- *celb*-**acy**
- *pig*-**let**
- *gos*-**ling**
- *false*-**hood**
- *minimal*-**ism**
- *runn*-**ing***

Identifying nouns

Syntactic Criteria

Say we have independent evidence for two other categories: **verbs** (like *is*, *ran*) and **determiners** (like *the*, *that*, *all*).

- If a word can "fit" between a determiner and a verb, it's a noun.
  - [DET ___ VERB]
  - [The **dog** ran]
  - [That **event** is tomorrow]
  - [All **genders** are represented]

Yet...
- *[The **tall** ran]
- *[That **the** is tomorrow]
- *[A **quickly** is represented]

Other positions nouns can occur:

- After adjectives: [the big **peanut** was eaten]
- After prepositions: [We ate at **home**]

Identifying nouns

These tests don't work for all types of nouns!

Sub-categories of nouns

Common nouns: can occur with determiners before them and have a plural form.
- **cat, the cat, cats, the cats**

Proper nouns: typically don't occur with determiners before them in English or have plural forms.
- ***Torontos**, ***the Derek** (but cf. Italian *la Maria*)

Pronouns: don't occur with determiners in English or the plural **-s** morpheme (though they do have plural forms).
- **I~we, you~y'all/yous/you guys, he/she/it~they**

Identifying nouns

More sub-categories of nouns

Common nouns can be further split in two ways:
- **Concrete nouns** refer to something in the real world while **abstract nouns** don't.
  - These tests work best for concrete nouns.
- **Count nouns** can be pluralized and **mass nouns** can't be.
  - **two trees** but ***two rices** (unless we mean kinds of rice)

Identifying verbs

Morphological Criteria

There are four **inflectional affixes** that attach to verbs in English:
- 3rd person, singular agreement marker **-s**,
- the past tense marker **-ed**,
- the progressive aspect marker **-ing**,
- the perfect marker **-en**.

- If a word occurs with these morphemes, it's probably a verb.
  - **demonstrate/demonstrate-s, sigh/sigh-ed, work/work-ing, fall/fall-en**
- If a word cannot occur with these morphemes, it might not be a verb.
  - **terribly/*terribli-es, that/*that-ed, some/*som-ing, tall/*tall-en**

Some verbs in English have **irregular** morphology
- **run/*runn-ed/ran, see/*se-ed/saw, go/*go-ed/went**

Identifying verbs

There are also several **derivational affixes** that attach to other grammatical categories and can result in verbs.
- origin-**ate**
- hospital-**ize**
- fals-**ify**

Identifying verbs

Syntactic Criteria

Say we have independent evidence for nouns

- If a word can come after a nouns and create a sentence, it's a verb.
  - [(DET) NOUN ___]
  - [He **laughed**]
  - [The dog **ran**]
  - [Defeat **hurts**]

Yet...

- *[He **dog**]
- *[The dog **he**]
- *[Defeat **sadly**]

Other positions verbs can occur:

- After or before adverbs: [I rarely **dance** quietly]

Identifying verbs

Sub-categories of verbs

Intransitive verbs: don't occur with nouns after them.

- **Doug laughed.** but ***Doug laughed Andy**.

Transitive verbs: require one noun after them. Strictly transitive verbs are rare in English.

- **Alex devoured the sandwich.** but ***Alex devoured**
- Other verbs can optionally be transitive: **Alex ate.** and **Alex ate the sandwich.**

Ditransitive verbs: require two nouns after them (a direct object and an indirect object)

- **I gave him candy.** but ***I gave candy.** and ***I gave him.**

Identifying verbs

Another distinction between verbs

Main verbs: Can be the only verb in a sentence.

- Have lexical content.
- John has **left**, Bill will **sing**, Sam was **sitting**.

Auxiliary verbs: Can never be the only verb in a sentence.

- 'helping verbs', co-occur with main verbs
- Usually have some grammatical information in them about tense, aspect or mood.
- John **has** left, Bill **will** sing, Sam **was** sitting.

Identifying adjectives

Morphological Criteria

There are two **inflectional affixes** that attach to adjectives in English: the comparative **-er** and the superlative **-est**.

- If a word can occur with the these morphemes, it's probably an adjective.
  - **big/bigger, slow/slower, fast/fastest, cool/coolest**
- If a word cannot occur with these morpheme, it might not be an adjective.
  - **terribly/*terribli-est, that/*that-er, man/*man-er, run/*runn-est**

Many adjectives can't attach to the **-er** and **-est** morphemes and form the comparative and superlative meaning with **more** or **most** before the adjective. You can use this as a test for adjectives too.

- **terrible/more terrible, peaceful/most peaceful**

Identifying adjectives

There are also a lot of **derivational affixes** that attach to other grammatical categories and can result in adjectives.

all adjectives!! {
- (*the*)*laugh*-**ing**(*man*)
- *act*-**ive**
- *comic*-**al**
- (*the*)*separ*-**ate**(*sheets of paper*)
- *girl*-**ish**
- *tire*-**some**
- *slime*-**y**
- *Chomsky*-**(i)an**
- *bliss*-**ful**
- *brother*-**ly**
- *fury*-**ous**

Identifying adjectives

Syntactic Criteria

Say we have independent evidence for nouns and determiners

- If a word can come before a noun and after a determiner, it is likely an adjective
  - [DET ___ NOUN]
  - [My **tall** friend]
  - [The **loudest** band]
  - [The **Chomskyan** approach]

Yet...

- *[The **dog** band]
- *[The **he** approach]
- *[My **sadly** friend]

Other positions adjectives can occur:

- Following *be* [John is **happy**] (but this overlaps with verbs)

Identifying adverbs

Morphological Criteria

Many adverbs end with the **-ly** derivational suffix.

- If a word ends in **-ly**, it might be an adverb.
  - **quickly, slowly, cooly, sadly**

Syntactic Criteria

- If a word appears in the following frame it is likely an adverb
  - [DET NOUN VERB ___]
  - [My friend ran **slowly**]
  - [The band played **well**]
  - [The cat meowed **loudly**]

  Yet...
  - *[My friend ran **dog**]
  - *[The band played **ran**]
  - *[The cat meowed **green**]

Identifying Determiners

Morphological Criteria

Determiners are a closed class. The following words are determiners in English.

- Articles: **the, a, an**
- Demonstratives: **this, that these, those**
- Quantifiers: **all, every, some, most, many, no, any...**
- Numerals: **one, two, three...**
- Possessive pronouns: **my, your, his, her, our...**
- some *wh*-words: **whose, which**

Identifying Determiners

Syntactic Criteria

- Determiners only ever occur before nouns or adjective noun sequences.
  - [___ (ADJ) NOUN]
  - [**the** (tall) man]
  - [**my** (fat) cat]
  - [**every** raccoon]

  Yet...
  - *[**laugh** (tall) man]
  - *[**we** (fat) cat]
  - *[**sadly** raccoon]

Identifying Complementizers

Morphological Criteria

There are only five complementizers in English.

- **that, if, whether, for**, and a "null" complementizer

Syntactic Criteria

- Complementizers connect sentences embedded within other sentences.
- If a word can appear in the following frame, it's likely a complementizer.
  - [NOUN VERB ___ NOUN VERB]
  - [John knows **that/if/whether/∅** Bill left]

  Yet...
  - *[John knows **rabbit** Bill left]

Identifying Conjunctions

Morphological Criteria

and, or, but, either, neither, nor are all conjunctions.

Syntactic Criteria

Conjunctions unite two words or phrases of the same type:

- [NOUN + NOUN] John **and** Mary
- [VERB + VERB] walk **or** sing
- [ADJ + ADJ] **neither** green **nor** red

Identifying Prepositions

Morphological Criteria

Prepositions are a **closed** class like determiners, complementizers, and conjunctions but there are about 70 of them in English.

- Indicate something about location or paths
- **to, from, under, over, with, by, at, above, before, after, through, near, on, off, for, in ,into, during, across...**

Syntactic Criteria

Prepositions can fit into the following frame, subject to an appropriate verb:

- [DET NOUN VERB DET NOUN ___ DET NOUN]
- [The boy threw the ball **down** the street]
- [The boy caught the ball **with** his glove]
- [The boy kissed the girl **on** the cheek]
- [The boy saw the cat **under** the stairs]

Exercise: Jabberwocky

'Twas brillig, and the **slithy toves**
Did gyre and gimble in the wabe;
All mimsy were the borogoves,
And the **mome raths outgrabe**.

"Beware the **Jabberwock**, my son!
The jaws that bite! The claws that catch!
Beware the Jujub bird, and shun
The **frumious** Bandersnatch!

He took his **vorpal** sword in hand:
Long time the manxome foe he sought—
So rested he by the Tumtum tree,
And stood awhile in thought.

Generative Rules

Generative Rules

Now that we are armed with the "atoms of syntax" we can start to see how the syntactic component of human language works.

We're going to see three key properties of syntax:

- Syntax is **infinite**.
- Syntax is **hierarchical** (composed of constituent parts).
- Syntax is **compositional**.

Templates have finite limits, syntax is infinite

We've been using **frames** (or **templates**) for our distributional tests of grammatical category.

- e.g. [DET NOUN VERB]
- Although templates are suitable for these tests, they are not efficient way to capture the power of the syntactic component of human language.

Templates have finite limits, syntax is infinite

	Templates							Example
1			N	V				Alice signed
2	DET		N	V				The rabbit signed
	DET		N	V			N	The rabbit saw Alice
	DET		N	V	DET		N	The girl saw the rabbit
3	DET	ADJ	N	V				The white rabbit left
	DET	ADJ	N	V			N	The white rabbit saw Alice
	DET		N	V	DET	ADJ	N	The girl saw the white rabbit
	DET	ADJ	N	V	DET	ADJ	N	The little girl saw the white rabbit

- If you had 1000 nouns and 1000 verbs, [N V] could get you 1,000,000 sentences
  - The more templates you have, number of things that you can say grows and grows...

Templates have finite limits, syntax is infinite

BUT... if you tried to use templates to describe every kind of sentence in a language, you'd soon discover, that you'd need an infinite number of templates.

Language has a property called **recursion**.

- We are able to **embedded** sentences within other sentences.
- If we can tack a [N V] sentence on to the end of another [N V] sentence, theoretically, we could do this forever.

Templates have finite limits, syntax is infinite

Pattern	Templates								Example
S	N	V							You know.
[S [S]]	N	V	N	V					They know you know.
[S [S [S]]]	N	V	N	V	N	V			They (don't) know we know they know.
[S [S [S [S]]]	N	V	N	V	N	V	N	V	They (don't) know we know they know we know.
...				...					...

Note that overt complementizers such as **that** can make these sound better.

Templates have finite limits, syntax is infinite

You can imagine the Friends scenario continuing:

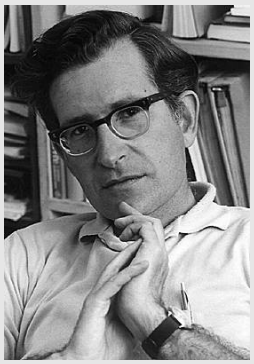
- Monica and Chandler might discover what Rachael and Phoebe know. It would then be the case that **"we know that they know that we know they know that we know".**
- Phoebe and Rachael could then discover that fact and they might say **"they don't know that we know that they know that we know they know that we know"**.

It could be an infinitely long episode and **we'd require an infinite number of templates**.

Templates have finite limits, syntax is infinite

In 1957, Noam Chomsky solved this long standing problem in linguistics.

- He proposed that syntax is **generative** and **recursive**
  - **Generative** in the sense that it generates only the grammatical sentences of a language and none of the ungrammatical sentences.
  - **Recursive** in the sense that some elements of the structure can reproduce themselves.

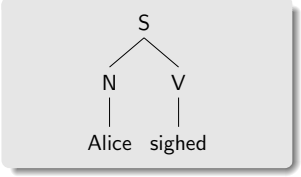


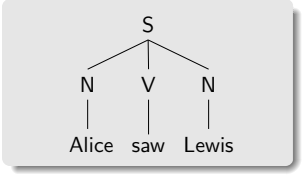
Some generative rules

Generative rules (Phrase Structure Rules)

- **A finite set of procedures** that can generate the **infinitly-possible** grammatical sentences of a language.
  - S → N V
  - S → N V N

Generative rules produce **syntactic trees**:

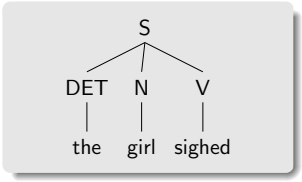


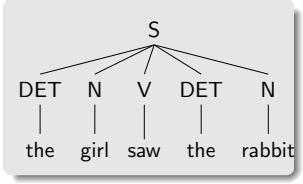


Some generative rules

Those two rules get us a few sentences. But we know there are more complicated ones... we can try to add more rules.

- S → DET N V
- S → DET N V DET N

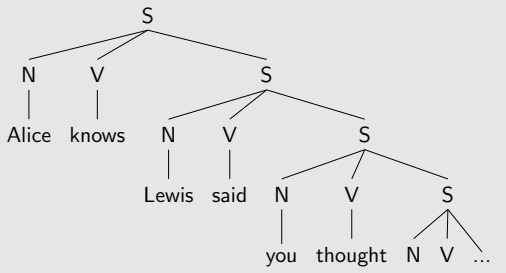




Some generative rules

Great, but these are still **finite**. One rule can get us an **infinite** number of sentences.

- S → N V S
  - A **recursive** rule: it can be applied to its own output over and over, resulting in a theoretically-possible infinite loop.

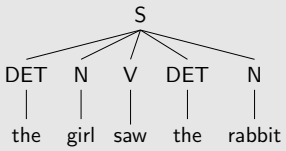


Core Properties of Syntax

First property: **syntax is infinite**.

Hierarchical Structures

The rules we've seen have been relatively **flat** giving a **linear** order to most of our structures.



However, syntax is not linear—it is **hierarchically organized** and composed of parts we call **constituents**.

- We're going to see that:
  1. A linear/flat structure doesn't work.
  2. What a hierarchical system looks like.

Linear or Hierarchical structure?

Option 1

Sentences are arranged in a **flat linear order**. There is no hierarchical structure. Words in a sentence don't group into 'units'.

Option 2

Sentences are arranged **hierarchically**. Words in a sentence group into larger 'units' which then group into larger 'units' etc.

Forming Yes/No Questions in English

Consider these two sentences:

(1) a. We can eat now.
b. Can we eat now?

- a. is a statement.
- b. is a question.

How do we form the question (b.) from the statement (a.)?

- Informally, it looks like we've moved **can** to the front of the sentence.
- Can we refer to only linear order to describe what happens with question formation?

Forming Yes/No Questions in English

Linear Rule (first try)

Move the second word to the beginning of the sentence:

(2) We can eat now. → Can we eat now
1 2 3 4 → 2 1 3 4

This works!

Forming Yes/No Questions in English

Let's try with a more complicated set of sentence.

(3) a. The fat cat can eat now.
b. Can the fat cat eat now.

Apply Linear Rule (first try)

Move the second word to the beginning of the sentence:

(4) The fat cat can eat now. → *Fat the cat can eat now
1 2 3 4 5 6 → 2 1 3 4 5 6

Our first try won't work. Let's revise our hypothesis

Forming Yes/No Questions in English

Let's grant our 'linear grammar' access to knowing about grammatical categories.

Linear Rule (second try)

Move the auxiliary verb (in this case **can**) to the front of the sentence.

(5) The fat cat can eat now. → Can the fat cat can eat now?
1 2 3 AUX 5 6 → AUX 1 2 3 5 6

This works not only for this sentence but also our first one!

(6) We can eat now. → Can we eat now?
1 AUX 3 4 → AUX 1 3 4

Forming Yes/No Questions in English

Let's try with an even more complicated set of sentence.

(7) a. The fat cat has been eating for a while.
b. Has the fat cat been eating for a while?

Apply Linear Rule (second try)

Which auxiliary verb do we move? The first (**has**) or second (**been**)?

(8) a. Has the fat cat been eating for a while?
b. *Been the fat cat has eating for a while?

Okay, let's revise our hypothesis to make reference to the **first** auxiliary.

- **Third Try**: Move the first auxiliary verb to the front of the sentence.

Forming Yes/No Questions in English

But what about...

(9) a. The fat cat who was sitting next to me has been eating for a while.
b. Has the fat cat who was sitting next to me been eating for a while?

Apply Linear Rule (third try)

Move the first auxiliary verb to the front of the sentence.

(10) a. The fat cat who **was** sitting next to me has been eating for a while.
b. *Was the fat cat who sitting next to me has been eating for a while?

Now we're stuck. You can try at home, but I guarantee that **we can't come up with a rule for English question formation by only referring to linear order**.

Forming Yes/No Questions in English

An Observation: Certain groups of words are "substitutable" in a sentence

a. Can **[the fat cat who was sitting next to me]** eat now?
b. Can **[the fat cat]** eat now?
c. Can **[the cat]** eat now?
d. Can **[Jammy]** eat now?
e. Can **[she]** eat now?

The **hierarchical** approach makes reference to these groups.

- We call them **constituents**.
- **Constituents** are internal syntactic structures; groups of words functioning as a unit.
- Represented between square brackets (**[ ]**)

The bolded groups of words surrounded by brackets all form a type of constituent called a **noun phrases** or **NP**.

Forming Yes/No Questions in English

Now, let's grant our grammar access to **constituent structure**, making it hierarchical.

Hierarchical Rule

Move the first auxiliary verb after the first **Noun Phrase** (NP) to the front of the sentence.

(11) a. **[$_{NP}$ We]** can eat now. →
b. Can **[$_{NP}$ we]** eat now?

(12) a. **[$_{NP}$ The fat cat]** can eat now. →
b. Can **[$_{NP}$ the fat cat]** eat now?

(13) a. **[$_{NP}$ The fat cat]** has been eating for awhile. →
b. Has **[$_{NP}$ the fat cat]** been eating for awhile?

(14) a. **[$_{NP}$ The fat cat who is sitting next to me]** has been eating for awhile. →
b. Has **[$_{NP}$ the fat cat who is sitting next to me]** been eating for awhile?

Core Properties of Syntax

First property: **syntax is infinite**.
Second property: **syntax is hierarchical**

Hierarchical Structures: More Phrases

NPs aren't the only phrases that make syntax hierarchical. There's lots of good evidence for other constituents.

- Noun Phrases (NPs)
- Verb Phrases (VPs)
- Adjective Phrases (AdjPs)
- Adverb Phrases (AdvPs)
- Prepositional Phrases (PPs)

There are more kinds of phrases and constituents, but using these phrases can generate almost all the sentences of English.

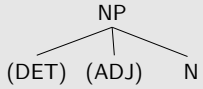
Hierarchical Structures: NPs

We've seen different kinds of NPs already. We can propose some generative rules to describe them:

- NP → N (Alice)
- NP → DET N (The cat)
- NP → DET ADJ N (The fat cat)

Each of these rules contains a **noun**, two contain **determiners** and one contains an **adjective**.

- We can reduce to a single rule if we recognize that determiners and adjectives are optional.
- NP → (DET) (ADJ) N



Hierarchical Structures: NPs

Evidence for NPs from substitution

Above we saw that we can substitute different NPs for one another and still have a grammatical sentence

Can **[the fat cat]** eat now?
Can **[the cat]** eat now?
Can **[Jammy]** eat now?
Can **[she]** eat now?

Evidence for NPs from movement

These same constituents can be moved as a unit in certain sentences

1a. I saw **[the fat cat]**. →
1b. It was **[the fat cat]** that I saw.
2a. I saw **[mice]**. →
2b. It was **[mice]** that I saw.

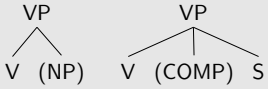
Hierarchical Structures: VPs

We also have a constituent we call a VP. The following rules for VPs can generate what we've seen.

- VP → V (NP)
- VP → V (COMP) S

For example:

(15) a. Alice [$_{VP}$ sighed].
b. Alice [$_{VP}$ saw [$_{NP}$ the rabbit]].
c. They [$_{VP}$ know (that) [$_{S}$ you [$_{VP}$ know]]].



Hierarchical Structures: VPs

Evidence for VPs from substitution

In English we can substitute *do/does/did* for entire VPs:

(16) a. Alice [$_{VP}$ sighed] and Lewis [$_{VP}$ **did**] too.
b. Alice [$_{VP}$ saw [$_{NP}$ the rabbit]] and Lewis [$_{VP}$ **did**] too.
c. They [$_{VP}$ know (that) [$_{S}$ you [$_{VP}$ know]]] and Lewis [$_{VP}$ **does**] too.

Evidence for VPs from movement

These same constituents can be moved as a unit in certain sentences

(17) a. Alice said she would **[$_{VP}$ sigh]** and **[$_{VP}$ sigh]** she did.
b. Alice said she would **[$_{VP}$ see [$_{NP}$ the rabbit]]** and **[$_{VP}$ see [$_{NP}$ the rabbit]]** she did.
c. They said they would **[$_{VP}$ know (that) [$_{S}$ you [$_{VP}$ came]]]** and **[$_{VP}$ know (that) [$_{S}$ you [$_{VP}$ came]]]** they did.

Hierarchical Structures: S

The grammar of English has very simple rule to generate all our sentences.

- S → NP VP

We can use these rules to produce syntactic trees of sentences. Let's tree one:

- The cat chased the raccoon.

Hierarchical Structures: S, NP, VP

Identify the grammatical categories

DET	N	V	DET	N
The	cat	chased	the	raccoon.

Identify the NP(s): NP → (DET) (ADJ) N

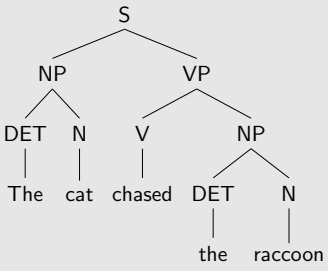
[NP]		[NP]		
DET	N	V	DET	N
The	cat	chased	the	raccoon.

Identify the VP(s): VP → V (NP)

		[VP		]
[NP]		[NP		]
DET	N	V	DET	N
The	cat	chased	the	raccoon.

Hierarchical Structures: S, NP, VP

Put it all together with your S: S → NP VP



Hierarchical Structures: Other Phrases

Adjective Phrases

Adjectives can be modified by degree words (DEG) like **very, really,** and **somewhat** and these two words form a constituent.

- AdjP → (DEG) ADJ

Adverb Phrases

Adverbs can also be modified by degree words and form a constituent.

- AdvP → (DEG) ADV

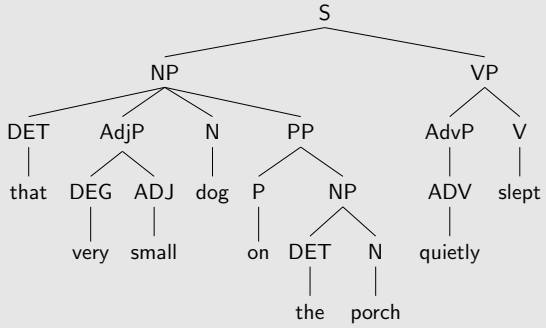
Prepositional Phrases

A preposition and its following NP also form a constituent.

- PP → P NP

Syntactic Trees

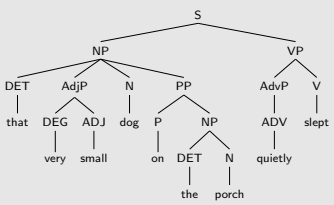
That very small dog on the porch quietly slept.



Syntactic Trees

The rules we need for this tree:

- S → NP VP
- NP → (DET) (AdjP) N (PP)
- AdjP → (DEG) ADJ
- PP → P NP
- VP → (AdvP) V
- AdvP → ADV

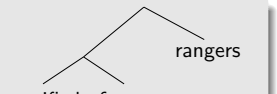


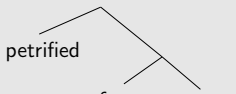
Compositionality

Another key property of human language syntax is that it is **compositional**.

The meaning of a string of words is determined by its component parts and their relations to one another.

- In other words, the order in which you combine **constituents** hierarchically is crucial to the meaning of the sentence.
- Just like math:
  - (1–2)–3 ≠ 1–(2–3)
  - [[petrified forest] rangers] ≠ [petrified [forest rangers]]





Core Properties of Syntax

First property: **syntax is infinite**.
Second property: **syntax is hierarchical**
Third property: **syntax is compositional**

Putting it all together...

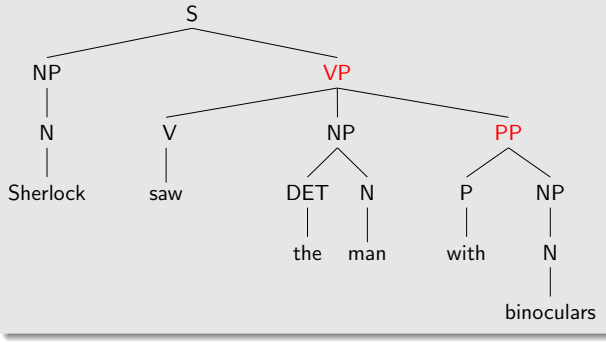
Sherlock saw the man with binoculars.

The following generative rules and a notion of compositionally can now explain the different interpretations.

- S → NP VP
- NP → (DET) N **(PP)**
- VP → V NP **(PP)**
- PP → P NP

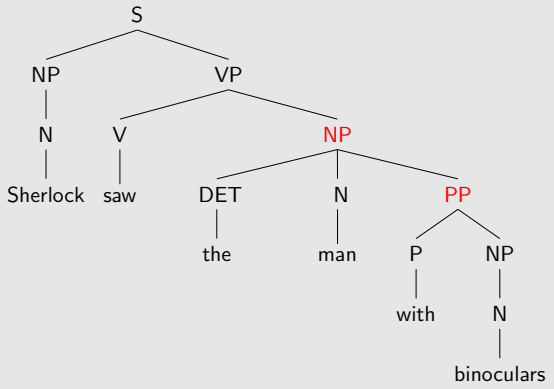
Sherlock saw the man with binoculars

Sherlock is seeing with the aide of binoculars



Sherlock saw the man with binoculars

The man that Sherlock sees has binoculars



Linguistic Diversity

The generative rules we've seen for English are NOT universal!

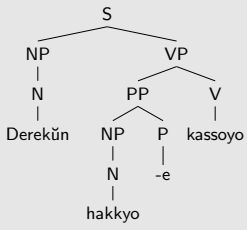
- Many languages have very different word orders!

Korean

(18) Derek-ŭn hakkyo -e kassoyo
Derek school to went
Derek went to school.

Rules for Korean:

- S → NP VP
- VP → PP V
- PP → NP P
- NP → N



For Next Week...

1. Read chapter 6 if you haven't and chapters 7 and 8.
2. Complete assignment 5. Available tomorrow!
3. I'll be posting your mini-research paper topics this week. You should choose your topic ASAP and start doing some research!
    - Proposal, Outline, and Annotated Bibliography due on Oct. 29!