Syntax: Study of Sentence Structure

Syntax is the component of the language that builds well formed phrases and sentences out of words and or morphemes. It is also the name of the branch of linguistics that studies the syntax component of natural language. As we discussed several times before, natural language is compositional. Larger structures are built by combining smaller pieces. Syntax is the component where words are combined together to generate well formed sentences. It consists of our subconscious knowledge about how to put words together to establish phrases and sentences. This is not a trivial task. Consider the following sentence.

(1) Education is a system of imposed ignorance. (Noam Chomsky)

This sentence consists of 7 words which can be permuted in 5040 different ways. Our knowledge of grammar, specifically the Syntax component, informs us that only about 2 out of 5040 permutations are well-formed while the other 5038 possible permutations are ungrammatical. The first well-formed permutation is already given in (1) and the second is given in (2).

(2) Is education a system of imposed ignorance?

Other permutations of these 7 words are mostly ill-formed. There might be one or two accidentally well-formed structures but they probably have a different meaning. Let's ignore them.

(3) *An is education system of imposed ignorance?

(4) *Education of a imposed is system ignorance.

(5) ...

Our knowledge of syntax constrains our grammar in a way such that we do not generate ill-formed sentences like (3) and (4). Thousands, in fact millions of such permutations are filtered out. Filtering out 5038 sentences and keeping only 2 is a seriously complex task. In fact, the number of sentences that need to be filtered skyrockets as we add more words. Consider the following sentence.

(6) The surest way to corrupt a youth is to instruct him to hold in higher esteem those who think alike than those who think differently. (Friedrich Nietzsche)

Sentence (6) has 25 distinct words which can be permuted in 15511210043330985984000000 different ways of which probably only a handful are well formed. Our subconscious knowledge of syntax generates only the few well-formed sentences and disallows the rest.

Big Picture Point

Some of the disallowed permutations in English are in fact allowed in other languages. For example, in Hindi (an SOV language), the permutation (7) is well-formed. Similarly, in Arabic or Irish (VSO languages) the permutation in (8) would be well-formed.

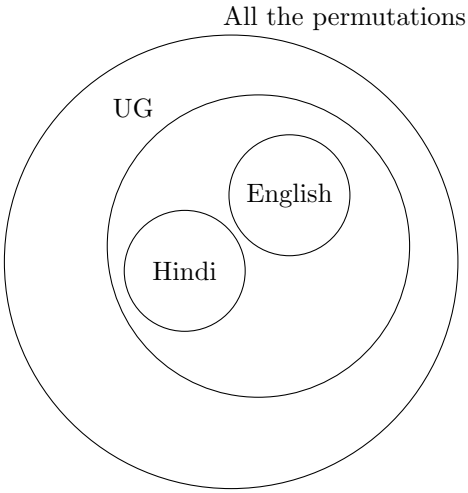
(7) Education a system of imposed ignorance is.

(8) Is education a system of imposed ignorance. (Not as a question but as an assertion)

However, we won't be able find all the permutations 5040 permutations across languages. No language would use the following permutation as far as we know.

(9) *Education ignorance a of is system imposed.

In fact, the number of attested permutations cross-linguistically is a small subset of all the possible permutations. This ties back to the idea of a **Universal Grammar**. Universal Grammar allows only a fraction of a set of all the possible permutations. Languages like English, Irish, Hindi, Spanish, etc. use a subset of the set provided by the Universal Grammar.



Big Picture Point ends here

Our knowledge of syntax actually goes beyond just telling us which permutations are allowed. It also lets us distinguish between different permutations that are allowed. For example, we know that (1) is used for assertions (declaratives) while (2) is reserved for question meanings.

How does syntax do all of this complex stuff?

The main function of the syntax is to put words together to generate well-formed sentences. While doing this, it is constrained by some principles and guided by some rules. For example, one of the fundamental principles is **compositionality**. Compositionality means that the whole is constructed by parts. Following compositionality, syntax puts two elements together at a time. This is called the **merge** operation. Some other rules and principles that guide syntax are **argument structure, thematic structure, case filter, movement principle, Binding Principle, etc.**. Each of these principles/rules constrain the syntax such that it generates only the well-formed structures while disallowing the ill-formed principles. The main task of a linguist is to identify these principles in a precise way to understand the Universal Grammar and the possible type of languages it generates.

Let us start with the argument structure.

Argument Structure

Each verb has an argument structure that informs the syntax about the number of arguments it must take to be well-formed. The idea of argument structure actually comes from the logico-mathematical elements called **functions**. At a deeper level, a verb can be defined as a function that needs arguments. This is enough math for now. We don't need to go into much detail about functions and their arguments.

An argument is an obligatory element (mostly a noun phrase) required by the meaning of a given verb. Having less or more arguments than the required amount causes ungrammaticality.

For example

(10) *John slept the balcony.

(11) *spelt.

(12) John slept.

The argument structure of a verb also has some information about the category of each argument a verb requires.

For example

(13) John gave Mary a book.

(14) John gave a book to Mary.

(15) *John gave Mary that she was late.

(16) John told Mary that she was late.

(17) John told Mary the story.

(18) John told Mar about the exam.

The examples above show that the verb *give* has three arguments. What's more, we also learn that the first two arguments of the verb *give* must be Noun Phrases while the third argument can be a Noun Phrase or a Prepositional Phrase but not a Complementizer Phrase. On the other hand, the verb *tell* has three arguments the frist two of which must be Noun Phrases while the third can be an NP, PP, or a CP.

The information about the argument structure of a verb is listed in the **lexicon**, our mental dictionary. We represent argument structure in the following way.

(19) $\text{Verb}_{[Arg1\ Arg2\ ...]}$

If an argument is optional, we put it in parentheses. If one of the arguments can be of different categories (NP, PP, etc.) We represent them between braces {.../...} with slashes between them.

For example

(20) $\text{give}_{[NP\ NP\ \{NP/PP\}]}$

(21) $\text{tell}_{[NP\ NP\ \{NP/PP/CP\}]}$

(22) $\text{sleep}_{[NP]}$

Argument structure is also called valency in some linguistics books. An interesting fact about languages is that a verb takes 3 arguments max. in many languages. Why should this be?
Argument structure is also related to the idea of **subcategorization**. Subcategorization means the items needed/selected by a syntactic object (verb, noun, etc.). We say the verb *give* subcategorizes for two NPs and one of the NP/PP.

Verb types Verbs are categorized based on the number of their arguments they can take.

(23) a. Intransitive = 1 argument
b. Transitive = 2 arguments
c. Ditransitive = 3 arguments

Thematic Structure

Another principle (theory) that constrains the syntax such that it does not generate unwanted structures is the **thematic structure**. Consider the following sentences.

(24) *The table gave Mary to the book.

(25) *The book saw the cat.

These sentences are ill-formed because the arguments don't seem quite right. For example, in (24) it is odd that the table is giving Mary away. Tables cannot do that. How can we instruct our syntax so that it does not generate such stupid sentences. We use thematic (a.k.a theta or θ) roles. Each verb lists some information about the theta roles of its arguments. The verb give needs its first NP argument to be animate and have volition. In other words, it needs an **agent**. As its second argument, it needs a **theme** argument and as its

third argument it needs a **goal** argument. These are theta roles.

Here are some common theta roles.

Agent: Agents are arguments that are animate and have some volition to initiate an event. They are the "doers" of an event.

(26) **John** called Mary.

(27) **Mary** kissed the leprechaun.

(28) The leprechaun was kissed by **Mary**.

Theme: Themes are the undergoers of an event. They are mostly objects in a sentence but not necessarily.

(29) John called **Mary**.

(30) Mary kissed the **leprechaun**.

Experiencer: Experiencers are the arguments that are psychologically affected by the event.

(31) **Bill** likes the book.

(32) The exam results pleased **the professor**.

Goal: Goals are the arguments towards which the event is directed.

(33) I sent **Mary** a letter.

(34) He gave a book to **Mary**.

Location: Location tells us the location of the event.

(35) I put the book **on the table**.

Theta Criterion
Each argument is assigned only one theta role and each theta role of a verb must be assinged to an argument. Arguments must be compatible with the theta role assigned to them. For example in (36), the verb *hit* assings an agent theta role to its subject but *table* cannot be an agent because it doesn't have volition. Hence, it is not compatible. This violates the theta criterion.

(36) The table hit John.

Practice
Identify the argument structures of the following verbs and the thematic roles of the arguments.

(37) Mary hit the table.

(38) Bill laughed.

(39) The book fell.

(40) The book was shipped to NYC.

(41) Harry placed the flute on the table.

Identify the problems in the following sentences.

(42) Rosemary hates.

(43) Jennie smiled the breadbox.

(44) The rock placed the sky with the fork.

Constituency & Phrases

Sentences consist of words that are structured in specific ways. Consider the following sentence.

(45) The tall guy picked the red apple.

On the paper, the words in (45) are just linearly ordered. This is basically the same when we utter or hear a sentence. We say or hear words one by one in a linear fashion. This linear representation does not tell us all the details about the relations between words in this sentence. In this sentence, intuitively some words have a closer relation to one another compared to other words.

For example
The words *tall* and *guy* have a closer relationship than the words *tall* and *pick* or *tall* and *apple*.

These sets of words that have a closer relationship in a sentence and can be treated as a unit are called constituents. For example in sentence (45), [*the tall guy*] is a constituent. We call it a DP, the short form for a Determiner Phrase.

But how do we know that [the tall guy] is a constituent but [the tall] isn't?

In order for a given set of words to be a constituent, they need to work as a unit at some level. We have some **constituency tests** that show us whether a given set is a constituent or not. These tests are **pro-form replacement**, **movement**, **coordination**, and **deletion**.

Pro-form Replacement Tests

A pro-form is a word that can replace another word or a set of words. If a group of words can be replaced by a pro-from, then it is a constituent. Consider the following sentence.

(46) The students solved the syntax problem in the class.

pronoun replacement
Anything that can be replaced by a **pronoun** in a sentence is a constituent and its category is a Determiner Phrase.

(47) a. [The students] solved [the syntax problem] in [the class.]
b. [They] solved [it] in [it/there.]

We represent the categories of constituents with subscripts on the left bracket.

(48) $[_{DP}$ The students] solved $[_{DP}$ the syntax problem] in $[_{DP}$ the class.]

do so replacement
Anyhting that can be replaced by **do so** is a constituent and its category is VP standiing for a Verb Phrase.

(49) The students solved the assignment in the class and the professors **did so**, too.

Here, "did so" refers to $[_{VP}$ solved the assignment in the class]
there, then Anything that can be replaced by "there or then" is a constituent. In general, these are prepositional phrases but not always.

(50) The students solved the problem **there**.

(51) $[_{PP}$ in the class]

one replacement
Noun phrases can be replaced by **one**.

(52) John solved the easy $[_{NP}$ problem].

(53) John solved the easy **one**.

Movement test

If a group of words can be moved totgether, then they must be constituents. One example of movement is **topicalization**.

(54) The old story, I like.

In (54), [the old story] is a constituent. Movement tests usuallly don't tell us what the category of the constituent is though.

Wh-movement
Most of the times, when we form a question in English, we have wh-movement. The element under question is replaced by a wh-word and moved to the beginning of the sentence. Anything that can be questioned via a wh-word is a constituent.

(55) John liked the old story.

(56) Who liked the old story.

(57) What did John like.

Clefting
Clefting is a structure where part of a sentence is embedded between "it is/was" and a relative clause. Here is an example.

(58) It was John, who left the door open.

The underlied part in (58) is a cleft. Anything that can be clefted is a constituent.

Coordination

Coordination shows us that the two coordinated elements are constituents and they have the same category.

(59) I bought [a book] and [a bag].

(60) He [shouted] and [left].

Deletion (Ellipsis)

Sometimes, we do not say everything in a sentence but the unsaid part can still be understood. In most cases, this is an example of deletion (ellipsis). Anything that is deleted as a unit is a constituent.

(61) I saw John but you didn't.

(62) [see John]

Sometimes one or two constituency tests won't work. We just need to find one that works. That's enough.

Quick Constituency Test List

- **pronoun** → DP
- **do so** → VP
- **one** → NP
- **there/then** → PP or DP

Practice Identify the constituents in the following sentences and label them with their categories.

(63) The old book fell under the table.

(64) The man on the street saw the cat on the tree.

Phrase Structure Rules

Constituency tests show us that words in a sentence are structurally organized into phrases. Phrases are really the fundamental elements of syntax. Words form phrases. Then, phrases form larger phrases. Larger phrases can form even larger phrases. This is recurscive and infinite. In fact, a sentence is a phrase that consits of other phrases.We will call sentences as TPs standing for Tense Phrases.

We want to make sure that we can form grammatical sentences by combining words and phrases in the right way. One way to do this is to use the **Phrase Structure Rules**. We can establish a finite amount of rules that tell us what is a well-formed structure. With these rules, we can create infinitely many phrases if we define our rules recursively.

Let's create a grammar of English with a set of Phrase Structure (PS) rules.

PS Rules for English (preliminary)

TP	→	DP VP
DP	→	D NP
NP	→	(Adj+) N
VP	→	V (DP) (DP/PP)
PP	→	P DP

Parentheses indicate "possible" phrases.
"+" sign indicates the possibility of many (probably infinite) of that category.

Can we generate a grammatical sentence with the PS Rules above using the words below?

{assignment, student, the, poor, hated, linguistics}

Can we decompose a sentence using the phrase structure rules above.

(65) The great emperors demolished some magnificent cities.

Consider the following sentence. Is this sentence grammatical based on the rules above?

(66) Kids saw a man.

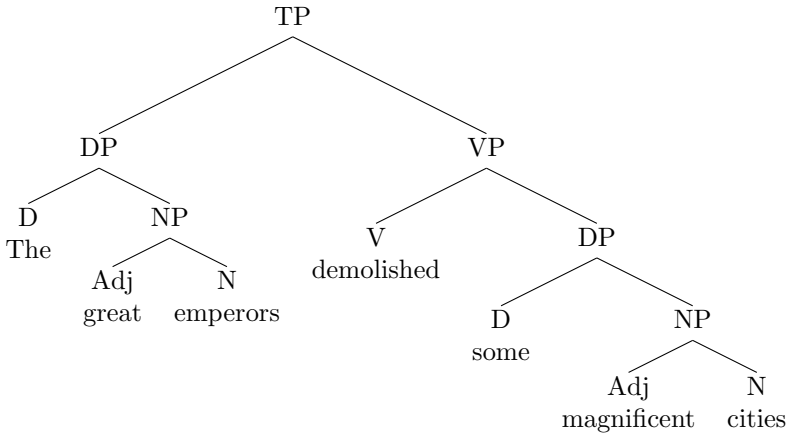
Tree Diagrams

So far, we worked on constituents and phrases. We can tell whether a group of words is a constituent. We can also tell its category label. We can represent this structure on sentences.

For example

(67) $[_{TP}\ [_{DP}$ The $[_{NP}$ great emperors]] $[_{VP}$ demolished $[_{DP}$ some $[_{NP}$ magnificent cities.]]]]

Brackets are hard to read. Hence, we use trees to represent the hierarchical structure in sentences. They are just two different ways of representing the same hierarchy. We can represent (67) with a tree diagram.



The tree above is a representation of the constituent and their structure. What is important is **hierarchy** and **structure**. Representations are important as long as they serve us understand this hierarchy. Otherwise, representations are arbitrary. We can use other ways of representation to indicate the hierarchy.

Practice

Indicate the constituent structures of the sentences below by applying constituency tests and drawing tree diagrams. Keep an eye on the Phrase Structure Rules in the previous page. Some of our PS rules are problematic and they won't generate these sentences. We might have to modify our PS rules.

(68) The nice picture hung on the wall.

(69) John bought a book.

(70) I gave Mary a book.

(71) I know that John loves Mary.

(72) The book that John saw belongs to Mary.

X-bar Theory

So far, we worked on Phrase Structure Rules.

CP	→	C TP
TP	→	DP VP
DP	→	D NP
NP	→	(AdjP+) N
VP	→	V (DP) (DP/PP) (AdvP)
PP	→	P DP
AdjP	→	(AdvP) Adj
AdvP	→	Adv

Phrase structures are handy for generating infinite number of sentences out of a set of finite rules. Yet, they are not enough for representing the actual hierarchy in language. There are two main problems with PS Rules. First, phrases are not uniform. One would expect phrases to be uniform in all languages if phrase building is a property of all human languages. Second, PS rules generate flat structures. For example the NP rule, tell us that adjectives and the Noun are merged at the same level. Similarly, Verbs and a bunch of DPs are merged at the same level acording to our VP rule. Is there a way to unify phrases so that they all have the same properties and they also represent the hierarchy?

- We need a unified Phrase Structure
- We need to make sure that only two things merge at a time (Binary branching)

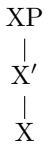
X-bar Theory

- A phrase is a projection of a lexical head (word). So, V projects VP; N projects NP, Adj projects AdjP, etc.
- Phrases are endocentric: The head determines the label of the phrase.
- Phrases abide by binary branching.

A phrase consists of three levels.

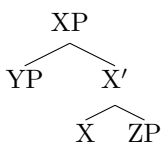
Head	X
Intermediary bar level	X′
Phrase level	XP

(73)



All phrases must have a head. A phrase can have a complement and a specifier.

(74)

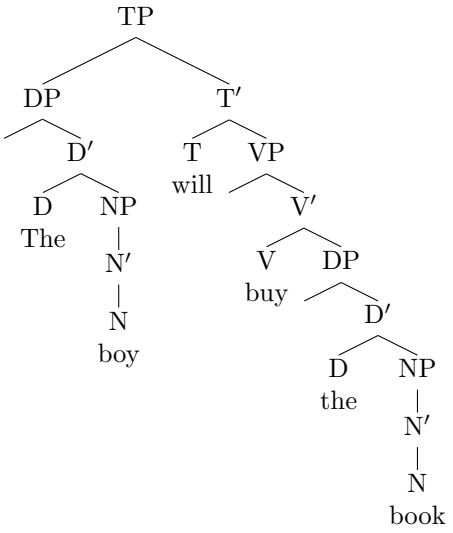


In (74), ZP is a complement of X while YP is the specifier of X (written and read as Spec, XP).

Generating specifier and complement positions is not always obligatory. The idea is that such positions can be generated.
Note: We will always generate a D head in a DP even if we don't see a determiner.

Given the X-bar Theory, we can draw the structure of the following sentence as in the tree in **??**

(75) The boy will buy the book.



Practice
John can carry all the boxes.

Argument vs. Adjunct

Previously, we talked about argument structure of verbs. Verbs can be intransitive, transitive, or ditransitive depending on the number of arguments they have. Removal of an argument from the sentence yields ungrammaticality.

(76) *John bought.

(77) *ran.

On the other hand, sentences can have some optional phrases other than the arguments.

(78) The **ugly** duckling swims **in the river**.

Those phrases which can be left out without violating the grammaticality of the sentence are called **Adjuncts**. Adjuncts, usually add extra bits of information about the sentence. However, they are not syntactically necessary. If we remove an adjunct, the sentence does not become ungrammatical. Usually, **adjectives, adverbs, and time/location/manner denoting phrases** are adjuncts.

Identify the adjuncts in the following sentences

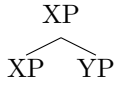
- Yesterday, I saw a little cat on the street.
- Roger was giggling rudely in the corner.
- The quick brown fox jumped over the lazy dog.
- Bill saw the man in the store with a telescope.

A good syntactic theory should be able to capture this difference between arguments and adjuncts. In X-bar theory, complement position is reserved for arguments. Specifier position is reserved for some arguments and some specific items. We need to find a position for adjuncts.

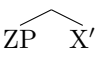
Some definitions

- A phrase is a projection of a head.
- Any lexical category can be a head. So, any lexical category can project a phrase: VP, NP, DP, CP, AdjP, AdvP, PP, etc.
- The phrase sister to a head is called the complement.
- The phrase which is sister of a bar level is called the specifier.
- The phrase that is sister to another phrase is an adjunct.

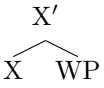
(79) YP is an adjunct of XP



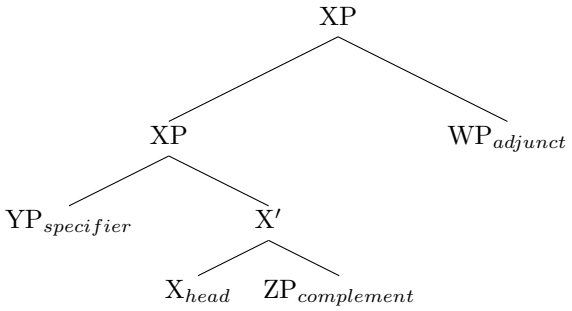
(80) ZP is the specifier of XP



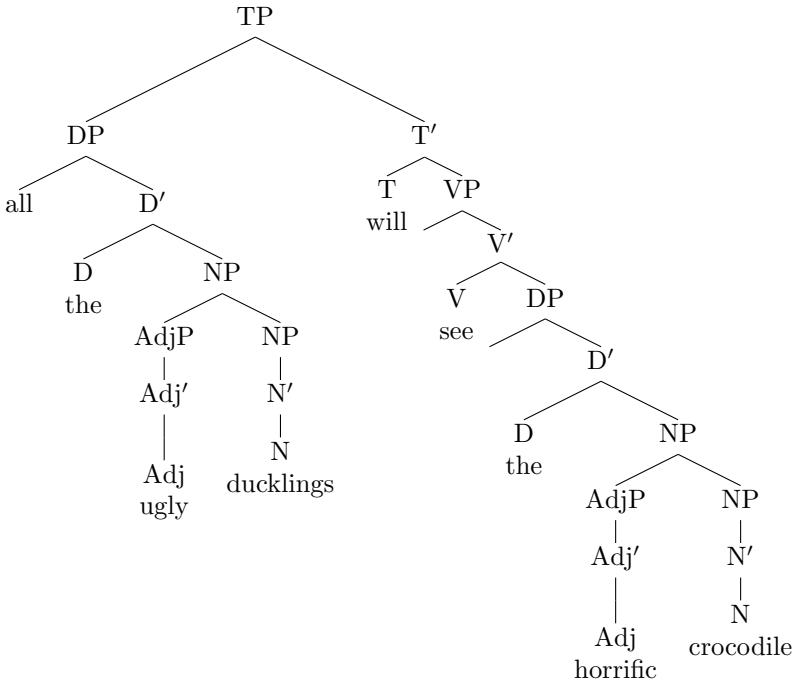
(81) WP is the complement of X



(82)



(83) All the ugly ducklings will see the horrific crocodile.



Practice
Draw the trees for the followign sentences.

- John ran slowly.
- The long boring discussion exhausted the audience.
- John knows that Bill slept well.
- John saw the man with a telescope.

You can draw here.

Exercises

Draw X-bar trees for the sentences below. Make sure that adjuncts are represented distinct from arguments. Note that

- Adjuncts are optional
- When you apply constituency tests like *do so* or *one*, adjuncts can remain outside while arguments (complements/specifiers) cannot.
- Adjuncts can be freely ordered while arguments cannot. You can switch the positions of two adjuncts but you cannot switch the positions of an argument and an adjunct.
- Arguments are always closer to the head than the adjuncts.

Sentences

- All the cherries will blossom in the spring.
- The chef tosses delicious salads without forks.
- John bought a book of poems with a red cover by Robert Burns.
- The little cat wonders if it will rain tomorrow.

Ambiguity

Language works hierarchically. When creating sentences (which are phrases), some words or some phrases are more closely related than some others. The way in which words and phrases combine create different meanings. For example, the word *early* can be an adjective or an adverb. As an adjective, it can modify nouns by *adjoining* to a noun phrase as in "an early bird". As an adverb, it can adjoin a verb phrase as in "wake up early". When we know the position where the word *early* adjoins, we can know whether it is an adjective or an adverb. More importantly, we can know what the intended meaning of a sentence is.

Although language works hierarchically, our externalization systems are not hierarchical. The way we externalize language is either by speech, or sign (written or gestural). In either case, some information regarding the hierarchy is lost because it is simply impossible to show hierarchy through a linear mechanism. For this reason, we get a fair amount of ambiguity in language. Here is an example.

(84) John saw the man with a telescope.

In sentence (84), the prepositional phrase "with a telescope" can be modifying "the man" or the event of "seeing". We can test this with our constituency tests.

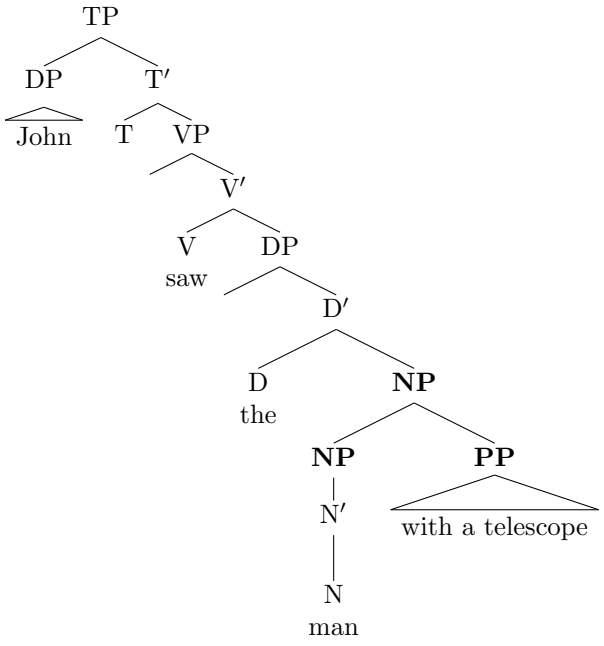
(85) John saw him. him = [the man with a telescope]

(86) John saw him with a telescope. him = [the man]

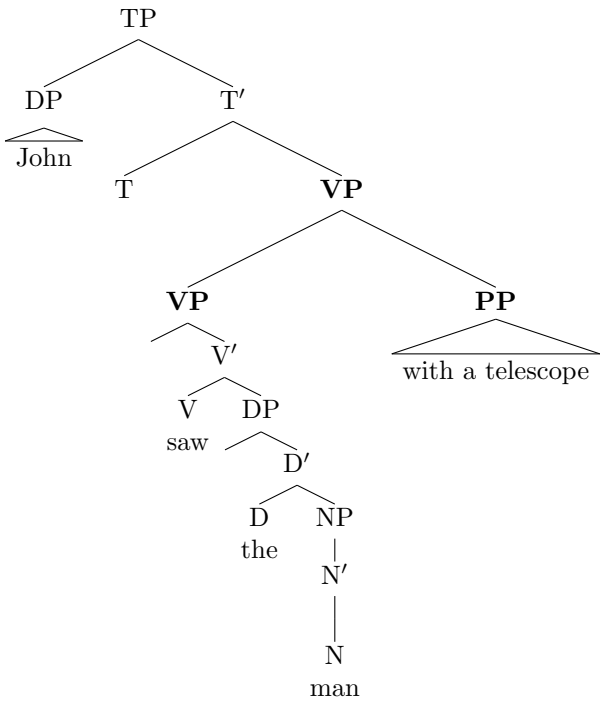
In (85), [with a telescope] modifies [the man]. In (86), it modifies the verb phrase.

Although some of the information about hierarchy is lost when we externalize sentences, we are still able to recover the actual sentence. We can understand these sentences. Because, we know their structures. For this reason, we should be disambiguate sentences by representing each meaning with teh right tree (phrase structure). In other words, we should be able to draw a tree per meaning and match meaning with trees.

(87) Meaning 1: the man has the telescope



(88) Meaning 2: John saw with a telescope.



A brief list of what modifies what

Adjective: modifies a noun by adjoining to a noun phrase (NP).

Adverb: modifies a verb by adjoining to a verb phrase (VP).

PP modifiers: can modify a noun by adjoining to a noun phrase (NP) or a verb by joining to a verb phrase (VP).

Realative clause: modifies a noun by adjoining to a noun phrase (NP).

(89) The man whom I saw yesterday.

Internsifier: can modifies an adjective by adjoining to an adjective phrase (AdjP) or an adverb by adjoining to and Adverb Phrase (AdvP). Some intensifiers are *very, quite, extremely, so, slightly, etc.*

(90) I saw a **very** tall man.

(91) He runs **very** fast.

Practice

- I saw the man in the store with binoculars.
- I wonder whether John will buy a house.
- I know that he will buy a fast car with a big engine.

Syntax Tree Drawing

Some Generalizations:

- Every word in a sentence projects (creates) a phrase.
- Every phrase consists of a head, a bar level, and a phrase level.
- Arguments and obligatory elements are either complements or specifiers.
- Modifiers are adjuncts. They are optional elements. They attach at the phrase elevel. For example, AdjP can modify an NP. In that case, AdjP attaches to NP but not N or N′.

Some general specifiers and complements

- A sentence is a T(ense) P(hrase).
- T (almost) always has a VP complement. Also, T always has a specifier. This specifier is mostly a DP.
- D almost always has an NP complement.
- V can have DP, PP, or CP complements. A V can exist without any complements (intransitive verbs).
- P always has a DP complement.

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(93) I saw a **very** tall man.

(94) He runs **very** fast.

Let's draw

(95)
a. The boy will run.
b. The boy will buy a toy.
c. The silly boy will buy a toy.
d. The tall silly boy will buy a toy.
e. The man with the glasses is reading the news.
f. The man whom I saw is running.
g. The silly boy with the glasses ran.

(96) a. John ran carefully.
b. John inspected the item carefully.
c. John talked about the issue.
d. John knows that Bill arrived.
e. John wonders if Bill arrived.
f. John saw the man in the warehouse.

(97) a. I know that he will buy a fast car with a big engine.
b. The American history teacher retired.

Movement

Movement (or displacement) is a very curious phenomenon that is observed only in natural languages but not in any artificial languages or communication systems as far as we know. What linguists call movement is basically this:

When an element which is interpreted in one position (say position A) appears in another position (position B), linguists believe that this is movement. They think that the moved element was first merged into the A positon but then it moved to the B position.

For Example
Consider the follwing sentence.

(98) *John will buy _____.

Sentence (98) is ungrammatical because the verb *buy* requires two arguments but there is only one argument. The complement of the verb is missing. It becomes grammatical, once we have a complement.

(99) John will buy *a book*.

Now, consider the following sentence.

(100) What will John buy _____?

Why is (100) not ungrammatical? Just like (98), it has nothing after the verb (the complement position). So, it should be ungrammatical but it isn't. (100) is a perfectly fine sentence in English. Instead of a phrase like *a book*, Sentence (100) has the word *What* and it is at the beginning of the sentence. This extra word *what* corresponds to *a book* (or something similar, e.g. a table, etc).

(101) a. **What** will John buy?
b. He will buy **a book**.

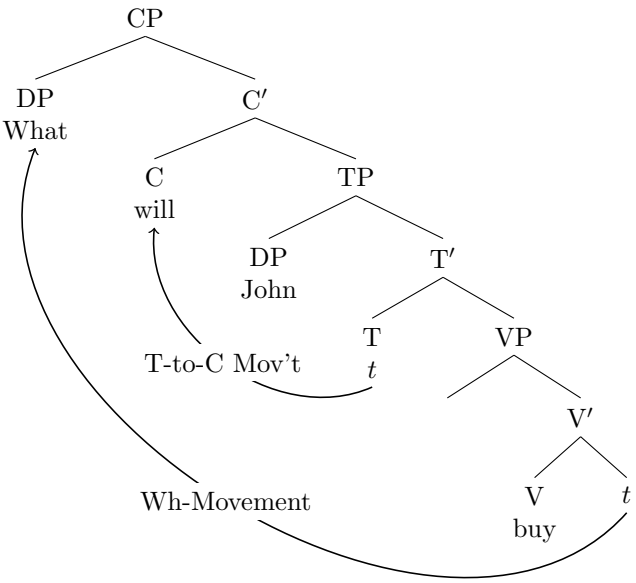
Based on the interpretation of the word *buy*, the argument structure of the verb *buy* and the correspondence between the question and the answer, we can argue that in fact *what* was generated in the complement position of the verb *buy* and then moved to its current position (beginning of the sentence).

Representing Movement

Given that we think Wh elements move to the beginning of the sentence, we need to be able to represent this on our syntactic representation. Also note that in (100), not only the Wh-element moves, but also the word *will* moves. This is called *T-to-C Movement*. The movement of the Wh word is called the *Wh-movement*.

We can represent movement as follows: First, we draw the basic X-bar tree representation of the sentence *John will buy what*. Then we move *will* and *what* into their relevant positions.

(102)



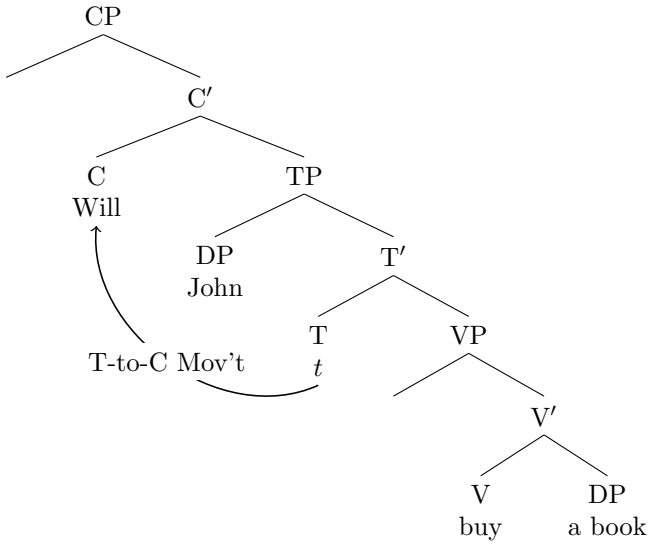
Yes/No Questions

In Yes/No questions (Polar Questions), we only move the auxiliary element to the beginning of the sentence.

(103) John will buy a book.

(104) Will John buy a book?

(105)



Practice

(106) Who will Bill see?

(107) When will you leave?