Phrase structure rules: X-Bar Theory

Intro to Generative Syntax
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1 X-bar Theory

- Consider the sentence in (1)

  (1) The student will read a book tomorrow.

- By applying constituency diagnostics, we can determine which words form a constituent.
- The grouping together of words into constituents can then be represented with a syntactic tree or with brackets.

  (2) The student will read a book tomorrow.

    a. [They] will read a book tomorrow.
    b. [Read a book tomorrow], the student will __.
    c. [Read a book], the student will __ tomorrow.
    d. The student will read it tomorrow.
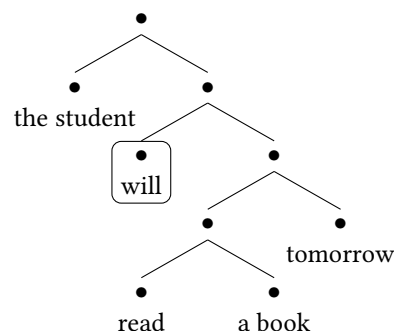   e. The student will read a book [then].

  (3)
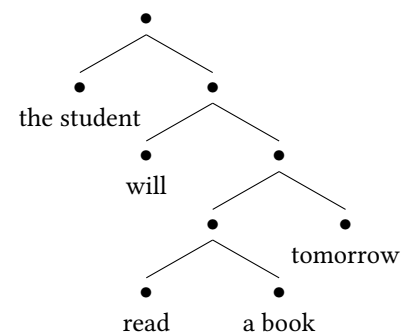
- What about *will*?

  ▷ Topicalization is an instance of a more general operation called **movement**. As the name suggests, it targets a constituent that occupies some position in the syntactic structure and displaces it to another position.

  ▷ We will talk about movement in more detail throughout the semester. What matters to us now is that **the operation movement only targets constituents**.

  ▷ Importantly, *will* can move in e.g. the so-called AUX-inversion necessary for question-formation:

    (4) *'Will' can move* ➡ *it must be a constituent*

    Will the student __ read the book tomorrow?

  ▷ That is why *will* gets to be a constituent on its own as well:

    (5)

- Notice how each word corresponds to a different simplex **node**, represented with '•'—we will talk about the internal structure of *the student* and *a book* soon.
- Additionally, separate words combine to form a complex node, e.g. *read a book tomorrow*—notice how there is a single node dominating this constituent.
- The whole sentence also corresponds to a single node (i.e. the topmost •).

> ▷ Each word in a sentence corresponds to a constituent, specifically, a terminal node.
> ▷ The whole sentence also corresponds to a constituent, though one that dominates everything else in the sentence.
> ▷ Each sentence is composed of different constituents.
> ▷ Besides terminal nodes, nodes can also be of the branching type: a branching node is one that is divided into other, smaller nodes.

- The representation in (3) captures the fact that sentences have an underlying complex structure, despite the fact that it is realized as a linear string.

> ▷ This is called a **syntactic tree**.

(6)   *Syntactic diagrams representing hierarchical structure are upside-down trees*

- The same can be represented with bracket notation:

(7)   *Hierarchical tree representation can be converted into bracket notation*

[$_a$ [the student] [$_b$ [will] [$_c$ [$_d$ [read]   [a book]]   [tomorrow]]]]
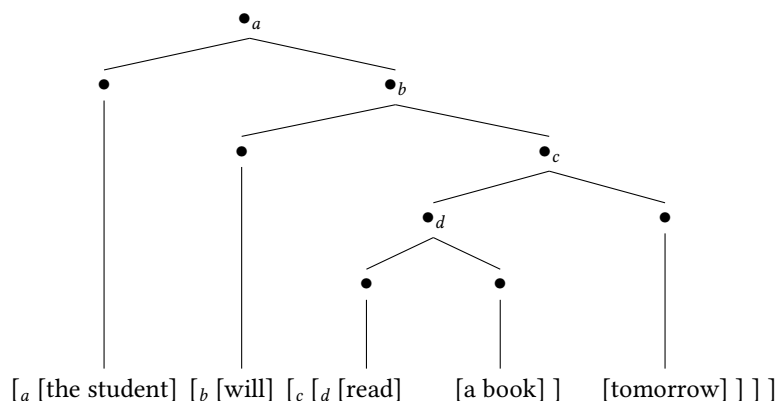
✒ **EXERCISE 1**

Identify the constituents in the sentence below, as it was done in (2).

(8)   They built a complex diorama in January.

---

(9)   *Hierarchical structure represented with tree diagram*

they
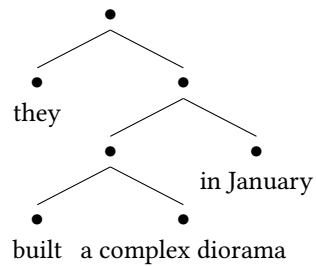built   a complex diorama
in January

(10)   *Hierarchical structure represented with brackets*

[ₐ [they]   [_b [_c [built]   [a complex diorama]]   [in January]]]
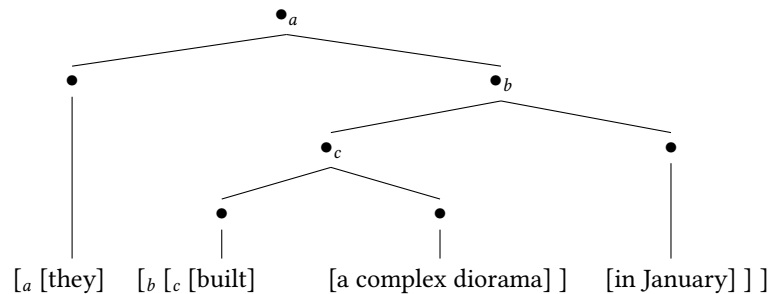
📝 **EXERCISE 2**

Convert the tree representation below into bracket representation. You may find it useful to label the different instances of •.

(11)   Snape hit the student with red hair.

Snape   hit   the   student   with   red   hair
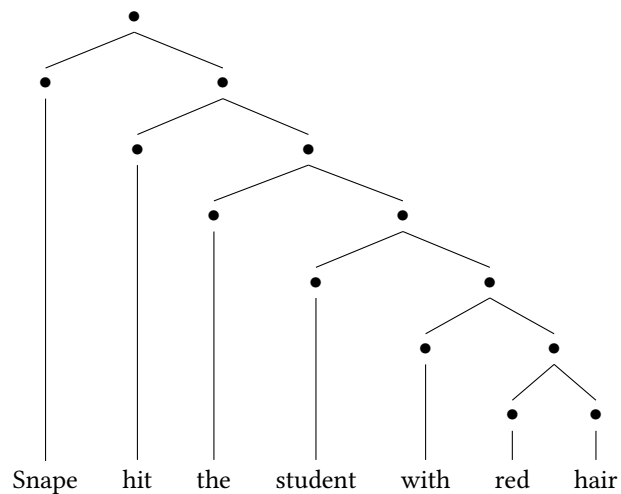
1.1 CATEGORIES AND NODES

- Now that we know how to represent the hierarchical structure of a sentence, we can supply a more explicit identity to the • used provisionally in the nodes.

(12) *Each node in a syntactic tree is labeled with a grammatical category, e.g. T(ense), Aux(iliary), V(erb), Adv(erb), D(eterminer), etc.*

```
                         TP
                  ┌──────┴──────┐
                 DP            T′
                ╱  ╲        ┌───┴────┐
          the student      T        VP
                          will   ┌───┴────┐
                                VP       AdvP
                             ┌───┴──┐      │
                             V      DP     Adv
                           read    ╱ ╲   tomorrow
                                 a book
```
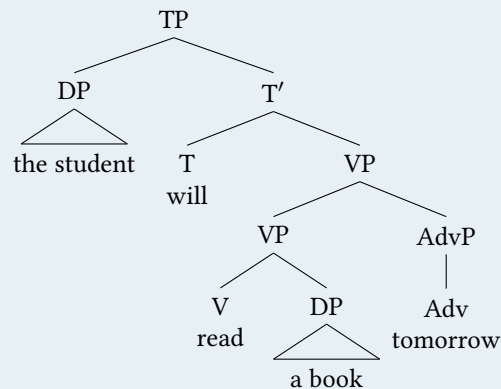
(13) Each grammatical category K̲ yields its own phrase K̲P

a.	verb	$\rightarrow$	VP	'verb phrase'
b.	noun	$\rightarrow$	NP	'nominal phrase'
c.	adjective	$\rightarrow$	AP	'adjectival phrase'
d.	preposition	$\rightarrow$	PP	'prepositional phrase'
e.	adverb	$\rightarrow$	AdvP	'adverbial phrase'
f.	auxiliary	$\rightarrow$	AuxP	'auxiliary phrase'
g.	tense	$\rightarrow$	TP	'tense phrase'
h.	determiner	$\rightarrow$	DP	'determiner phrase'
i.	complementizer	$\rightarrow$	CP	'complementizer phrase'

...

1.2 X-BAR THEORY

- Each sentence projects a structure according to a set of rules provided by Universal Grammar called **X-Bar Theory**.

🏳 **DEFINITION 1**

(14) *X-Bar Theory: projections*

```
                    XP ◄── maximal projection / phrase level
                 ╱     ╲
              (αP)      X′ ◄── intermediate projection
                     ╱    ╲
        head ──► X        (βP)
```
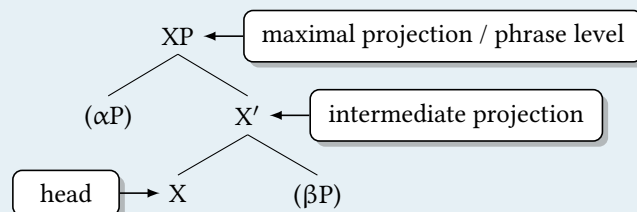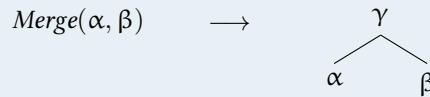
▷ X is a variable that ranges over **any** grammatical category: V(erb), N(oun), P(reposition), C(omplementizer), Neg(ation), A(djective), T(ense), Adv(erb), Aux(iliary), D(eterminer), etc.
▷ *X′* is pronounced 'X-bar.'

- These levels of projection are created when the head X combines with other phrases (e.g. αP, βP, etc).
- The operation responsible for combining X with some phrase is called **Merge**.
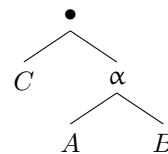
> 🚩 **DEFINITION 2**
>
> (15) a. **Merge** is a syntactic operation that applies to two elements α and β, forming a new element, γ. γ immediately dominates α and β.
>
> $$Merge(\alpha, \beta) \qquad \longrightarrow$$
>
> (tree: γ dominating α and β)
>
> b. γ *immediately dominates* α and β *iff* there is one single descending line connecting γ to α and one single descending line connecting γ to β and, furthermore, there is no node *e* that γ dominates and which dominates α or β.

(16) *Merge is **recursive***

  a. $Merge(A, B) = \alpha$
  b. $Merge(\alpha, C) = Merge(Merge(A, B), C)$

(tree: • dominating C and α; α dominating A and B)

(17) *Analogy: recursion as Matryoshka dolls[1]*

- The structure yielded by Merge has particular positions:
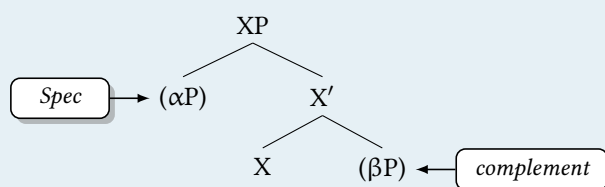
> 🚩 **DEFINITION 3**
>
> (18)
>
> (tree: XP dominating Spec → (αP) and X′; X′ dominating X and (βP) ← complement)
>
> a. **Complement**: the constituent that a head X merges with.
> b. **Specifier**: a constituent that is sister to an intermediate projection X′ and which is dominated by the maximal projection XP.

  ▷ The occurrence of specifiers and complements depend on the requirements that each X makes (more on the next topic, *Argument Structure*).

---

[1]Source of images: `https://en.m.wikipedia.org/wiki/Matryoshka_doll`, accessed: 2025-01-21.

▷ All the logical possibilities:

> ### ▷ DEFINITION 4
>
> The occurrence of specifiers and complements depend on the requirements that each X makes.
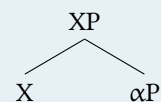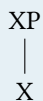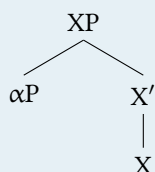>
> ❶ X does not require either a complement or a specifier.
>
> ❷ X requires a complement only.
>
> ```
>     XP                          XP
>     |                          /  \
>     X                         X    αP
> ```
>
> ❸ X requires a specifier only.
>
> ❹ X requires both a complement and a specifier.
>
> ```
>        XP                          XP
>       /  \                        /  \
>     αP    X'                     αP    X'
>           |                           /  \
>           X                          X    βP
> ```
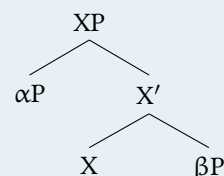
○ The only levels that must be projected are the head (X) and the maximal projection (XP).
○ The intermediate projection X′ only occurs if a specifier is required by X.

- Besides a Spec and a complement, a constituent can also merge with an optional **adjunct**.

> ### ▷ DEFINITION 5
>
> (19) *X-Bar Theory: adjuncts*
>
> ```
>                 XP ◄─── Merge(XP, adjunct) results in a duplicated XP.
>                /  \
>              XP    (γP) ◄─── An adjunct merges with an assembled XP.
>             /  \
>         (αP)    X'
>                /  \
>               X    (βP)
> ```
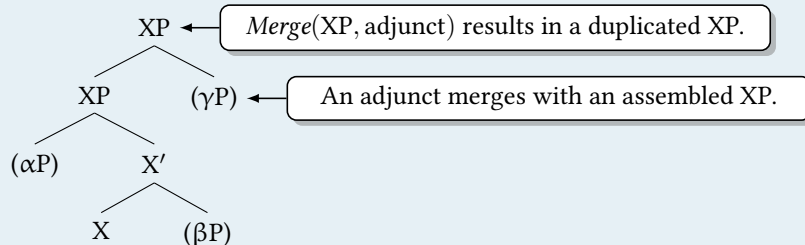
▷ Adjuncts are always optional and, in principle, there could be an infinite number of them.
▷ An adjunct is merged after the complement (if there is one) and after the specifier (if there is one) is merged.
▷ This is done so via duplicating the XP level, as many times as there are adjuncts.
▷ Textbook examples of adjuncts are adverbs and adjectives:

(20) We watched a (long) (beautiful) movie (yesterday).

(21) a.

```
              DP
           ╱      ╲
          D        NP
          a      ╱    ╲
              AdjP     NP
               │     ╱    ╲
              Adj  AdjP    NP
             long   │       │
                   Adj      N
                beautiful  movie
```

b.

```
              VP
           ╱      ╲
          VP       AdvP
        ╱    ╲       │
       V     DP     Adv
    watched  ╱╲   yesterday
           a movie
```
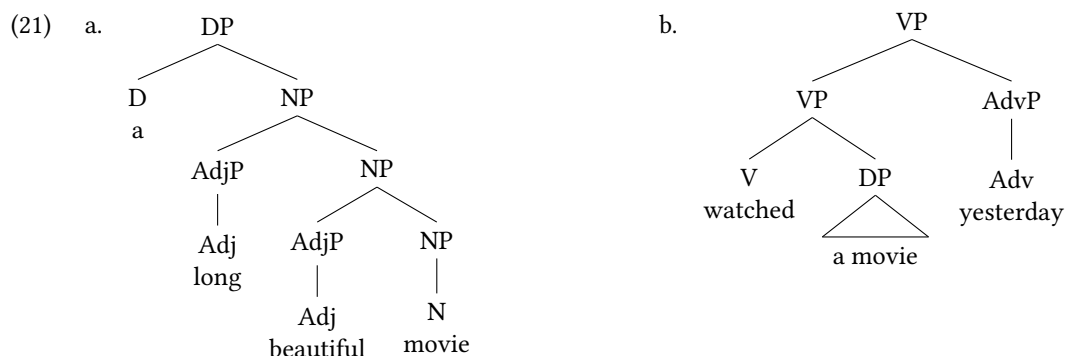
🛈 **Right now, we are only concerned with how adjuncts are represented**.

▷ What an adjunct is (and how it differs from an argument) is going to be defined in the next topic, *Argument Structure*.

2   Clause structure: TP, AuxP, and VP ———————————————

- Let's start getting used to drawing trees.
- **A clause is projected from Tense, which forms a TP (i.e. a Tense Phrase)**.

  ▷ The reason is that, without tense, a clause cannot be used as a standalone sentence:

  (22) *Tensed clause*

      a. … Moussa said [the defendants are guilty].

      b. … [The defendants are guilty].

  (23) *Tenseless clause*

      a. … Moussa proved [the defendants to be guilty].

      b. … [The defendants to be guilty].

  ▷ An example of a tenseless clause is the infinitival clause in (23). In English, it is identifiable by the *to* that precedes the verb. The latter is, furthermore, in bare form—i.e. without tense or agreement morphology.
  ▷ Unlike the tensed clause (22b), the tenseless clause (23b) is ungrammatical.

- Now that we established that a sentence is a TP, we can examine its internal structure.

> (24) *TP internal structure*
>
>   a. The head of TP is occupied by the tense of the sentence (i.e. [pres, pst]). If there is an auxiliary or modal verb (e.g. *will*, *have*, *can*, *might*, etc), T is occupied by it.
>
>   b. The Spec position of TP is occupied by the subject of the sentence.
>
>   c. The complement position of TP is occupied by a VP (i.e. a Verb Phrase).

(25) Moussa wore a sweater.

```
              TP
          ┌────┴─────┐
         DP          T′
         ┌─┐      ┌───┴──────┐
       Moussa    T           VP
               [PST]      ┌───┴───┐
                         V        DP
                        wore     ┌──┐
                             a sweater
```
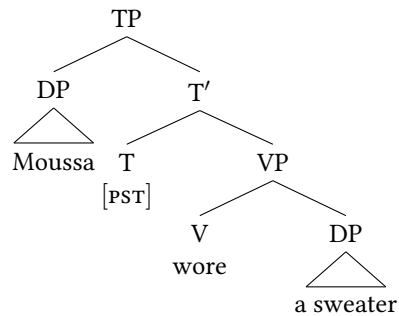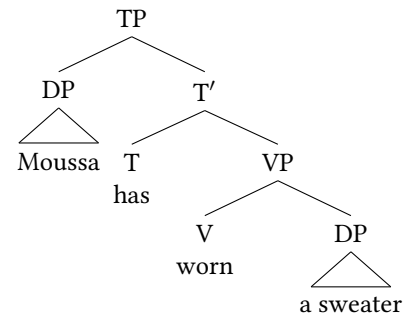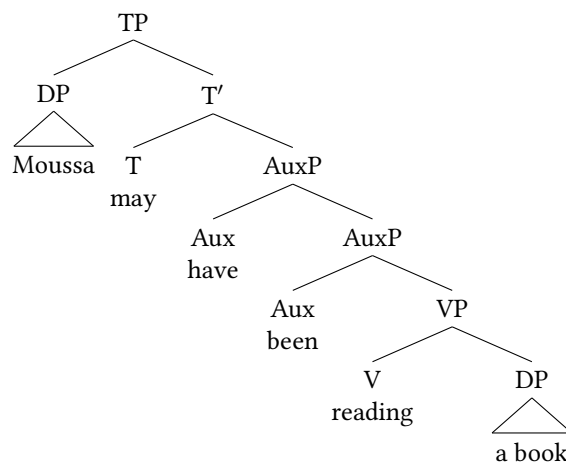
(26) Moussa has worn a sweater.

```
              TP
          ┌────┴─────┐
         DP          T′
         ┌─┐      ┌───┴──────┐
       Moussa    T           VP
                has        ┌───┴───┐
                          V        DP
                        worn      ┌──┐
                              a sweater
```
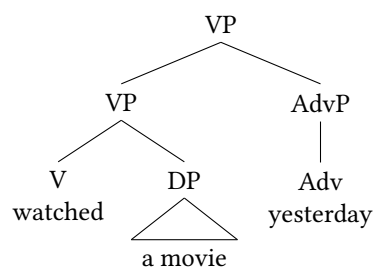
- Auxiliaries in English can be stacked. In this case, the highest one goes at the head of TP and the subsequent auxiliaries head AuxPs.

(27) Moussa may have been reading a book.

```
                TP
          ┌──────┴──────┐
         DP             T′
         ┌─┐        ┌────┴──────┐
       Moussa      T            AuxP
                  may        ┌────┴─────┐
                            Aux         AuxP
                           have     ┌────┴─────┐
                                   Aux         VP
                                   been     ┌───┴────┐
                                           V         DP
                                        reading     ┌──┐
                                                 a book
```

> (28) *VP internal structure*
>
> a. The VP is projected from the main verb of the clause, i.e. the verb that carries lexical meaning (as opposed to an auxiliary, which carries grammatical information such as tense, aspect, or modality).
>
> b. A lexical verb may have at least one object.
>
> c. There can be any number of adjuncts adjoined to the VP.
>
> d. Besides AdvPs (cf. (21b), Prepositional Phrases (PPs) can be VP adjuncts too.

(29)
```
              VP
          ┌────┴────┐
         VP         AdvP
       ┌──┴──┐       │
      V      DP      Adv
    watched ┌─┐    yesterday
         a movie
```

(30)
```
            VP
        ┌────┴────┐
       VP         PP
        │        ┌─┐
       V     in the morning
     snowed
```

EXERCISE 3

A. Draw trees for the sentences below. For now, abbreviate the structure of the subject and object with a triangle with the category Determiner Phrase (DP).

(31)   a. Max said a word.
         b. Eyglo wrote a letter.
         c. Eyglo may have been writing a letter.

B. The object of a verb can be another clause:

(32)   Max said [**that** Eyglo wrote a letter].

Propose a structure for the sentence in (32), assuming that the **subordinate** or **embedded** clause is a Complementizer Phrase (CP) whose head is the complementizer *that*. *That*, in turn, takes a TP as its complement.

DEFINITION 6

▷ Sentences can be monoclausal or bi-/multi-clausal.
▷ A sentence is monoclausal if it contains only one clause, which is identifiable with a predicate like a verb.

(33)   Loredana will have **finished** the book.

▷ A sentence is biclausal if contains more than one predicate.

(34)   a. Seb **said** [that Loredana will have **finished** the book].
         b. [That Loredana will have **finished** the book] was **surprising**.
         c. Seb **believed** [Loredana to have **finished** the book].

➠ Every sentence is a clause, but not every clause is a sentence.

DEFINITION 7

If a sentence is biclausal, the main clause is called a **matrix** clause, while the clause that is selected by it is called an **embedded** clause.[2]

(35)   Seb said [that Loredana will have **finished** the book].
       matrix   *embedded*

---

[2] The matrix clause is also called *main clause* and the embedded clause, *subordinate clause*.

> ✏️ **EXERCISE 4**
>
> X-Bar Theory applies in both head-initial and head-final languages. Draw trees for the sentences below:
>
> (36)   a.   Ram ate a banana.
>
>   b.   raam-ne kelaa khaayaa.   (*Hindi, Indo-Aryan*)
>   Ram-ERG banana ate
>   'Ram ate a banana.'
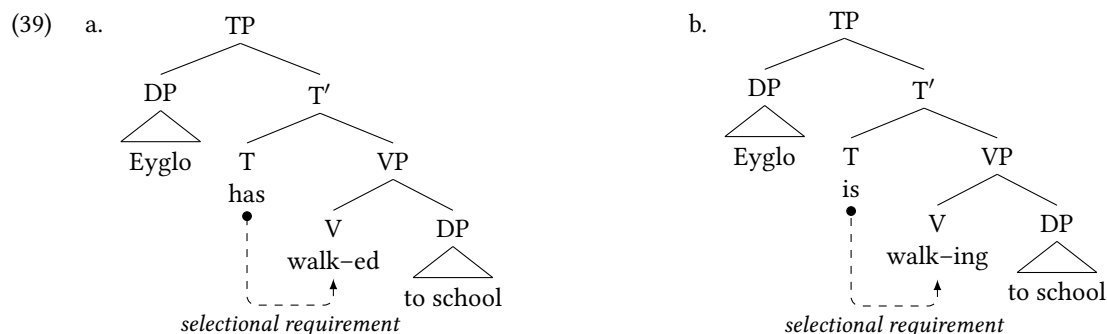
2.1   VERB MORPHOLOGY AND SELECTIONAL RESTRICTIONS

(37)   *English has verbal affixes such* –*ed for* [PST] *and* –*s for* [PRES 3SG].

     a.   Eyglo walk–ed to school.

     b.   Eyglo walk–s to school.

- Tense, according to our theory so far, is represented at T. However, the verb is represented at the head of a VP, bearing the verbal suffix that encodes tense:

(38)   a.

selectional requirement
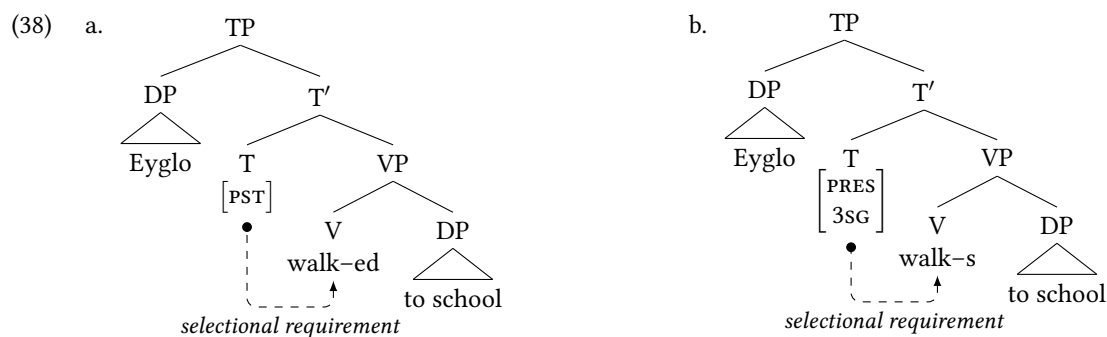
- If the verb already has a tense suffix in (38a–38b), is it redundant to present tense (viz. [PST] and [PRES] in (38a–38b)) at T as well?
- In a future chapter about case and agreement, tense (as well as agreement) will be represented at T only, and then an operation called Amalgamation will put together the tense suffix at T with the verb at the head of the VP.
- For the moment, we will assume that T imposes a **selectional requirement** on the AuxP or VP that is its complement.
- For instance, a [PST] selects a VP headed by a verb in the past form (38a), while a [PRES] selects a VP headed by a verb in the present form.
- This requirement is more general. As mentioned above, if T is headed not by a tense future, but by an auxiliary, that auxiliary imposes restrictions in its complement too:

(39)   a.

```
              TP
          ┌────┴────┐
         DP          T′
        ╱──╲      ┌───┴───┐
      Eyglo      T         VP
                has      ┌──┴──┐
                 •      V       DP
                 ┊   walk–ed   ╱──╲
                 ┊      ↑    to school
                 └──────┘
              selectional requirement
```

b.

```
              TP
          ┌────┴────┐
         DP          T′
        ╱──╲      ┌───┴───┐
      Eyglo      T         VP
                 is     ┌──┴──┐
                 •      V       DP
                 ┊   walk–ing  ╱──╲
                 ┊      ↑    to school
                 └──────┘
              selectional requirement
```

▷ The auxiliary *have* requires a participial form (39a), while the auxiliary *be* requires a progressive or gerund form (39b).

✎ **EXERCISE 5**

Draw a trees for the sentence below:

(40)   Snape hit Harry and Ron with a book.

Assume the following structure for the coordinated phrase *Harry and Ron*:

(41)

```
                &P
            ┌────┴────┐
          DP          &′
         ╱──╲      ┌───┴───┐
       Harry      &         DP
                 and       ╱──╲
                           Ron
```

---
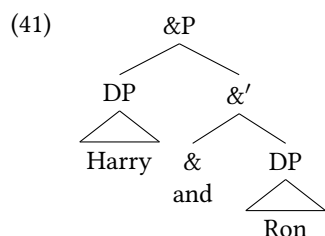
3   NOMINAL STRUCTURE

- We can now turn to the internal structure of nominals to complete our representations.
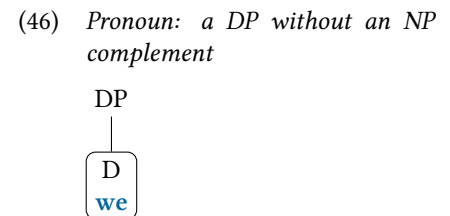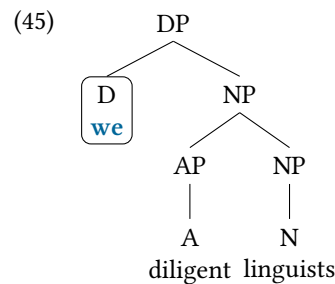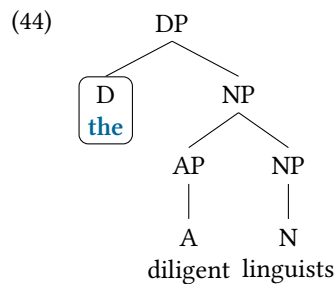
(42)   *DP internal structure*

     a.   'DP' stands for **Determiner Phrase**.

     b.   The term 'determiner' encompasses different types of articles like *the* and *a*, as well as demonstratives like *this*/*these* and *that*/*those*.

     c.   A DP can have a Nominal Phrase (NP) as its complement.

     d.   The NP can have an Adjectival Phrase (AP) as an adjunct—note that the NP level was duplicated in order for the adjunct to be merged into the structure.

- A nominal expression like *the diligent linguists* is represented as follows:

(43)

```
        DP
       /  \
      D    NP
     the   /  \
        AP    NP
        |      |
        A      N
     diligent linguists
```
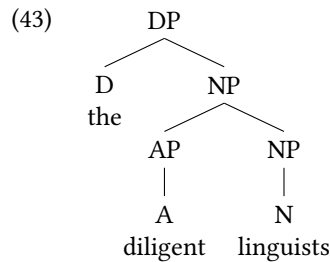
- Pronouns are also considered to be determiners. The reason is that there are nominal phrases such as *we diligent linguists*, represented in (45). This is parallel to (43).
- A standalone pronoun is a DP without an NP complement, as represented in (46).

(44)

```
        DP
       /  \
     [D]   NP
     the   /  \
         AP    NP
         |      |
         A      N
      diligent linguists
```

(45)

```
        DP
       /  \
     [D]   NP
     we    /  \
         AP    NP
         |      |
         A      N
      diligent linguists
```

(46) *Pronoun: a DP without an NP complement*

```
   DP
   |
  [D]
   we
```

- Every category projects its own structure. The same holds of adjectives like *diligent*.

(47) *Every category, including A(djectives), projects its own structure.*

```
   AP
   |
   A
 diligent
```
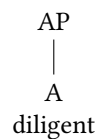
> ✒ **EXERCISE 6**
>
> Draw a tree for the sentences below, now providing a representation for the internal structure of the subject and object DPs too.
>
> (48)   a. An employee may have ignored the long announcements from the supervisor.
>   b. Snape hit a student with red hair.

- What happens to proper names like *Faatu* and *Loredana*?
- We will assume that they are also DPs, but one where the determiner is phonologically null (represented as 'Ø'). The proper name heads the NP that is the complement of the DP.

(49) *Proper names (in English): a DP with a null head*

```
      DP
     /  \
    D    NP
    Ø     |
          N
       Loredana
```
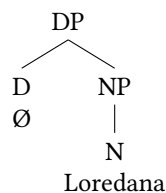
- Why would we think that proper names project a phonologically null DP?
- In languages like Brazilian Portuguese and Shuswap, proper names can be preceded by a determiner:

(50) *Brazilian Portuguese* (Romance)

[DP **A** Loredana] vai ter terminado o livro.
   the Loredana goes have finished the book
'Loredana will have finished the book.'

(51) *Shuswap* (Salish)

Wík-t-Ø-s   [DP **re** John].
see-TRANS-3SG.OBJ-3SG.SUBJ   DET John
'S/he saw John.'

▷ Hence, crosslinguistically, assuming that a proper name is a DP is not implausible.

- Additionally, pronouns and proper names can occur in the same position:

(52) *Distribution: pronouns and proper names can occur in the same position*

a. [DP She]   will have finished the book.
b. [DP Loredana]   will have finished the book.

▷ It is plausible that proper names have the same category because the same distribution and behavior (e.g. both occur in the subject position).

- In fact, even in a language like English proper names may be preceded by a determiner, as long as there is a modifier such as an adjective (e.g. *late* or *dear* or a relative clause (RC):

(53) *Even in English can proper names be preceded by an overt determiner*

a. **the** late John Smith
b. **the** John Smith [RC that I know]
c. **my** dear John Smith

(54) *Another instance of null determiner: bare singulars and bare plurals*

a. **Students** will be notified of changes in the schedule.   b. Snape hit the student with **red hair**.
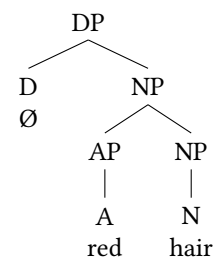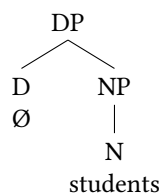
✎ **EXERCISE 7**

Draw diagrams for each of the readings of *The enraged cow injured the farmer with an ax*. You may want to consult the representations of sentences (40) and (48b).

> **Exercise 8**
>
> Draw trees for the sentences below. If a sentence is structurally ambiguous, draw a tree for each of its readings.
>
> (55) a. Claire went to the bank.
>   b. Solfrid baked the cake in the freezer.
>   c. I saw tall trees.
>   d. The teacher said that the students will eat a cake after the lecture.
>   e. The blond engineer and the tall historian published some books.
>   f. Intelligent students and teachers will win a prize.

4 Summary

- Sentences are organized in terms of constituents. In other words, sentences have an internal hierarchical structure, with words that "belong together" forming a constituent.
- This hierarchical structure can be represented with syntactic trees, where each constituent represents a node. Nodes can themselves be internally complex, being composed of smaller nodes.
- The component of the grammar responsible for regulating the internal structure of sentences is called X-Bar Theory.