

Structural Relations

The mathematical properties of phrase structure trees

Important!

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- [Even if you have trouble with the formal definitions, try to understand the **INTUITIVE** idea behind them. Don't get lost in the details of the formalism.

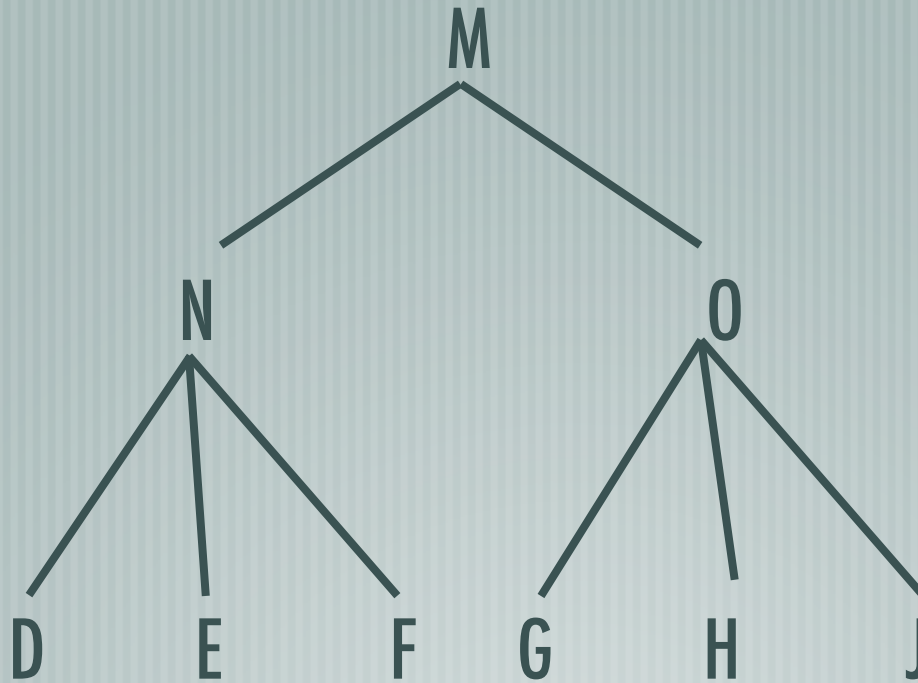
Structural Relations

— [**Structural relations:** the formal relationships between items of a tree

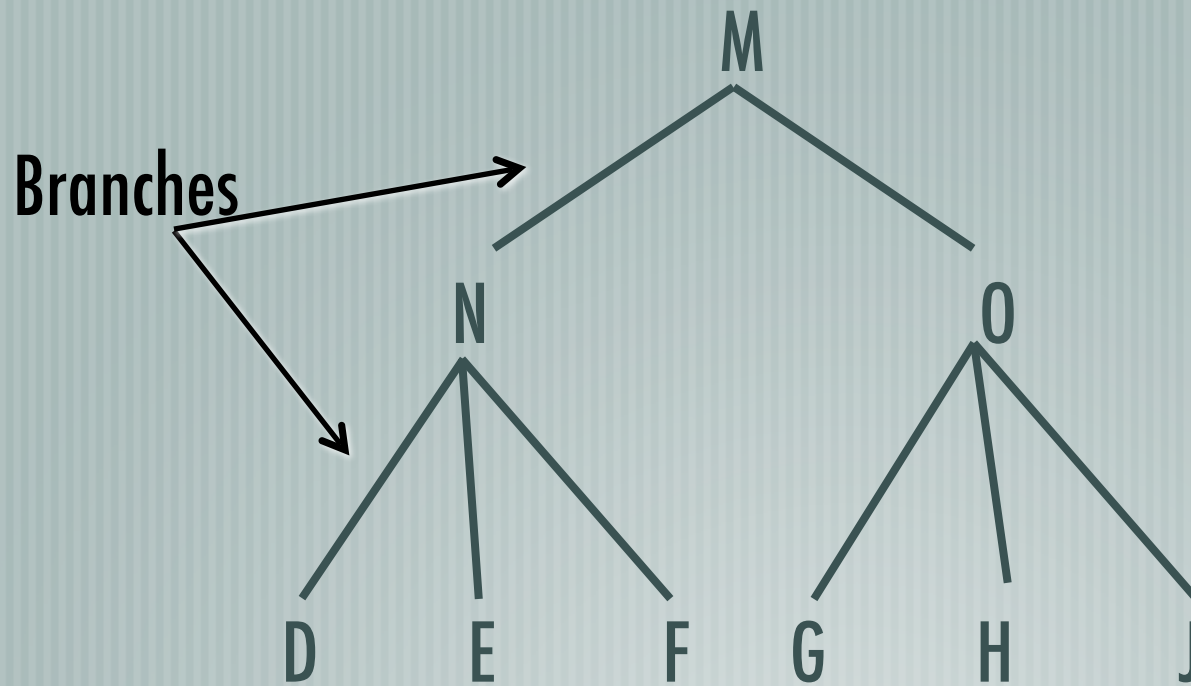
— [**Why should we care?** We want to be able to talk about specific relationships in terms of structures.

— [*Structural relations are actually very simple!
Don't let the formalism scare you!*

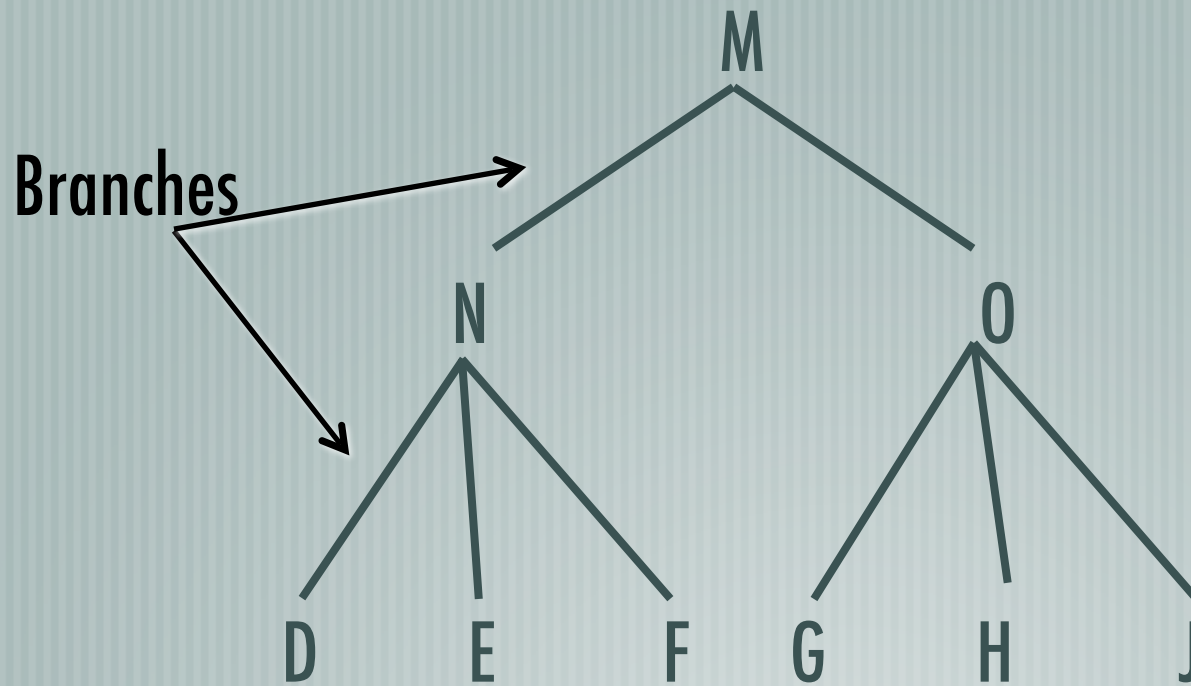
Some basic terms



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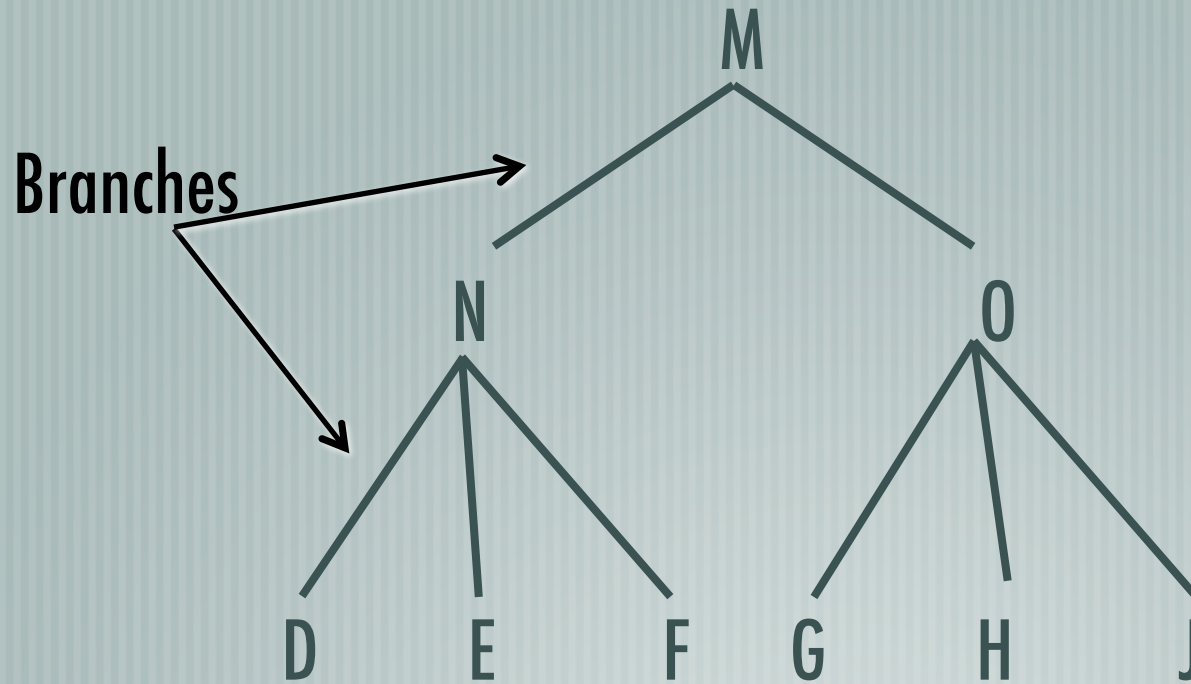


Some basic terms



Labels: M, N, O, D, E, F, G, H, J

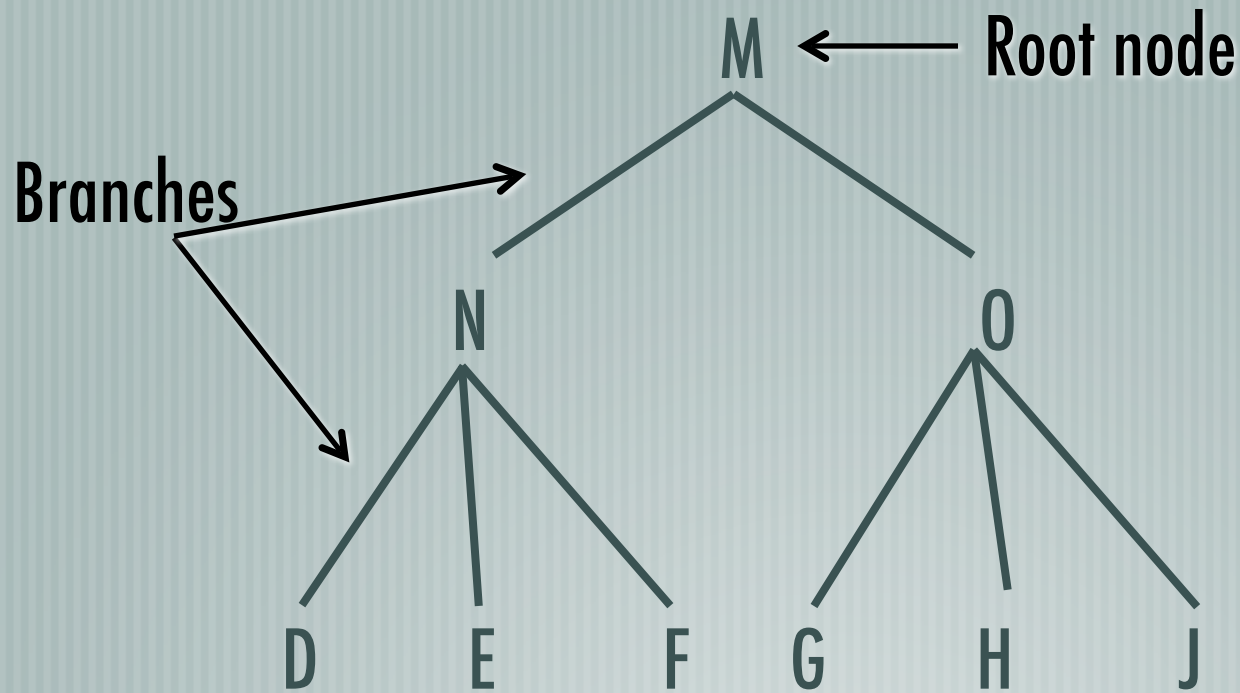
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Node: Any point with a label

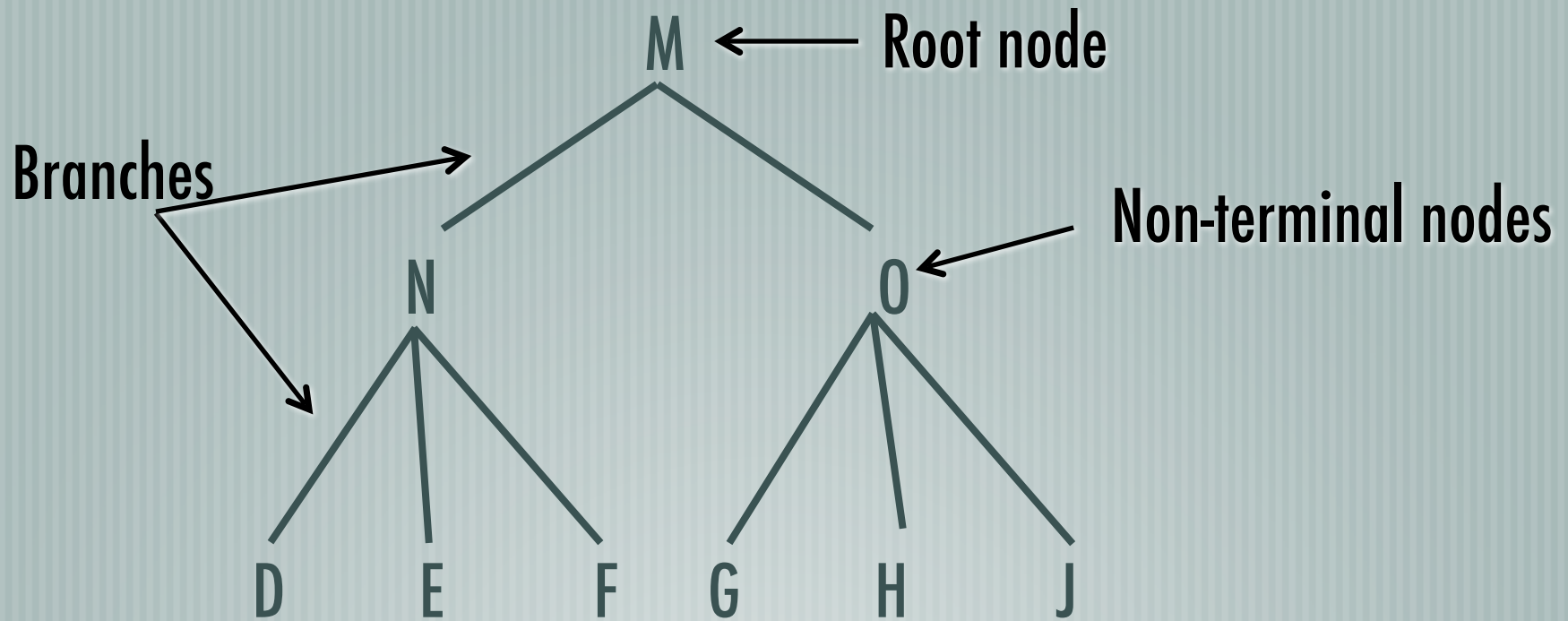
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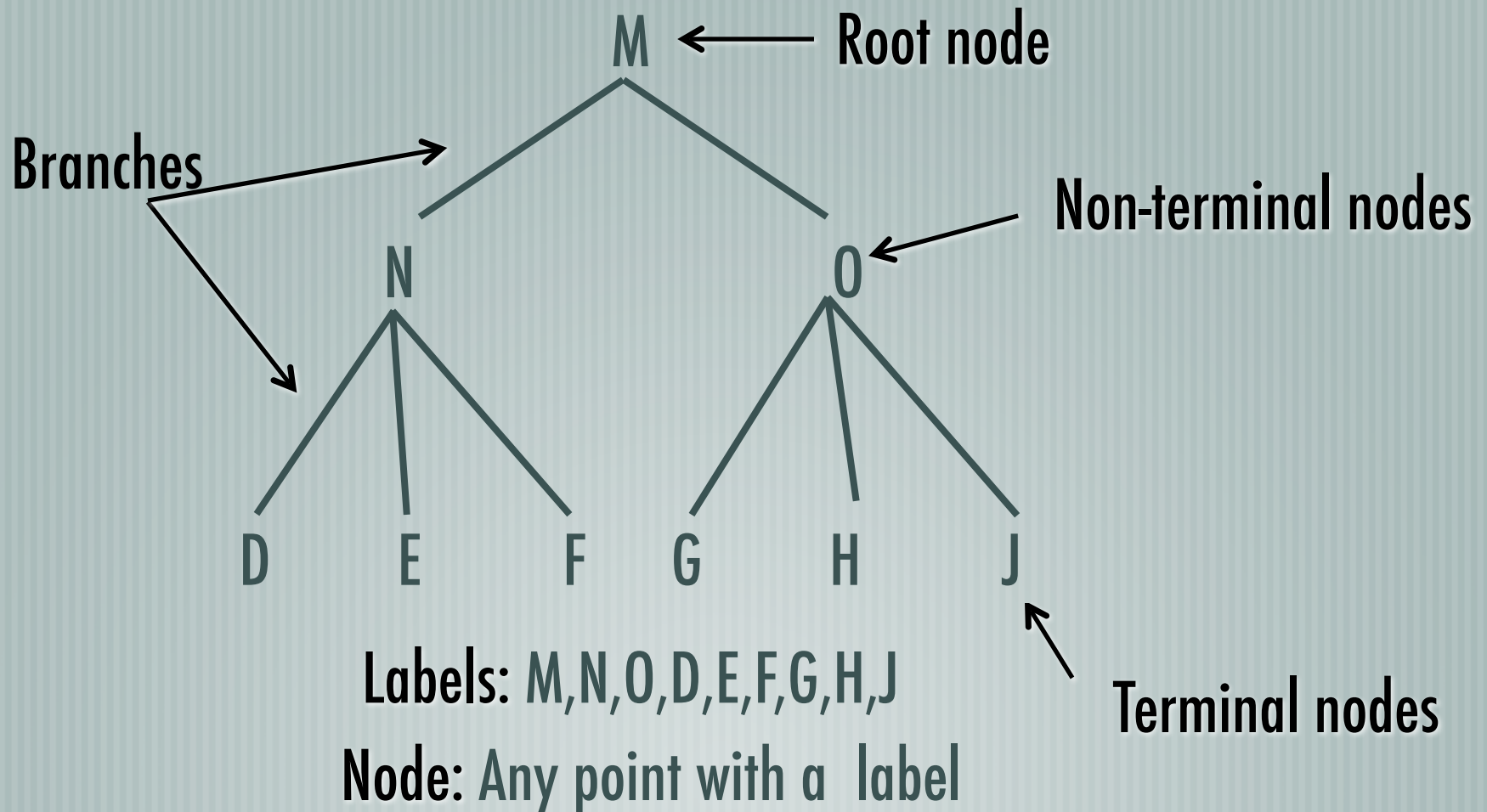
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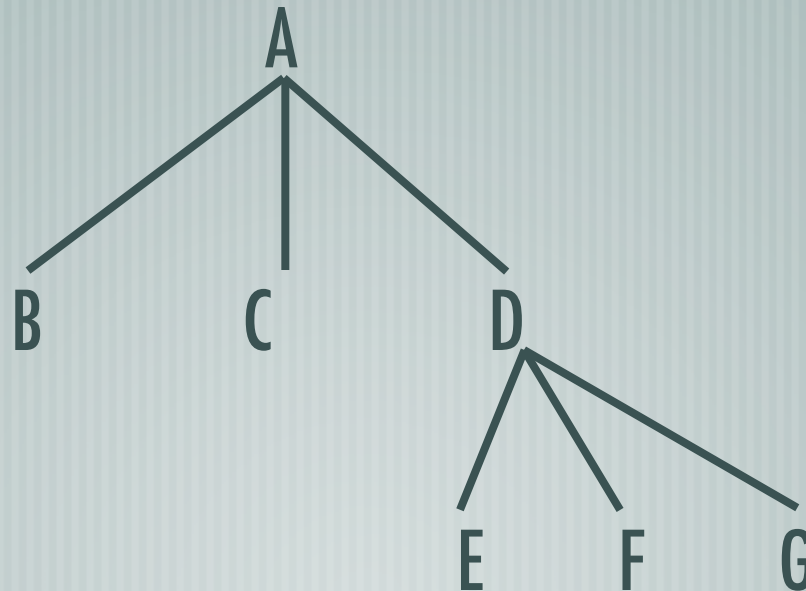
Domination

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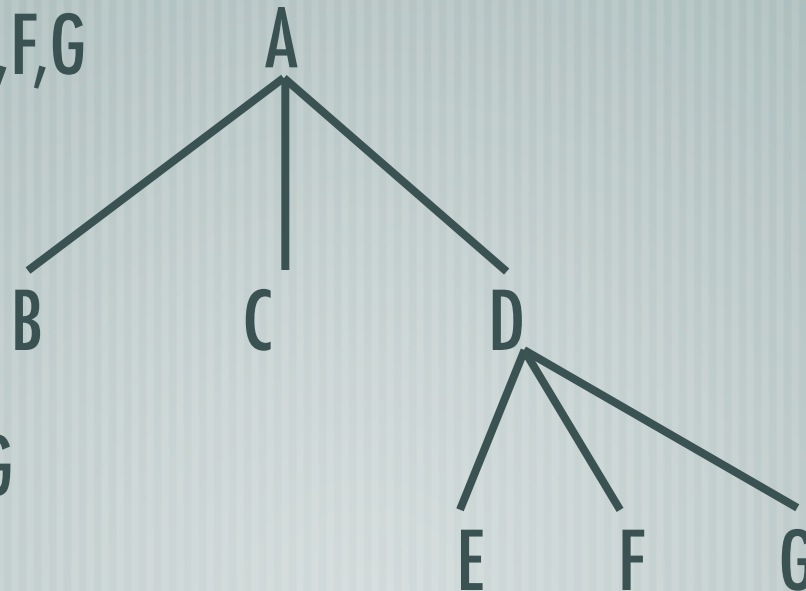
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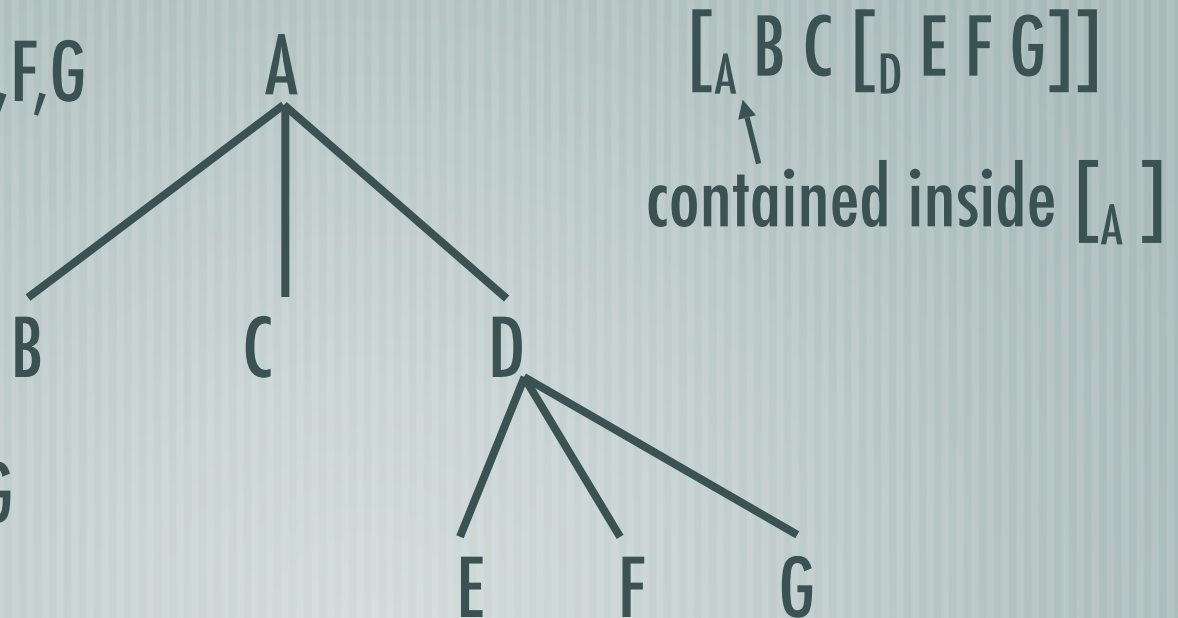
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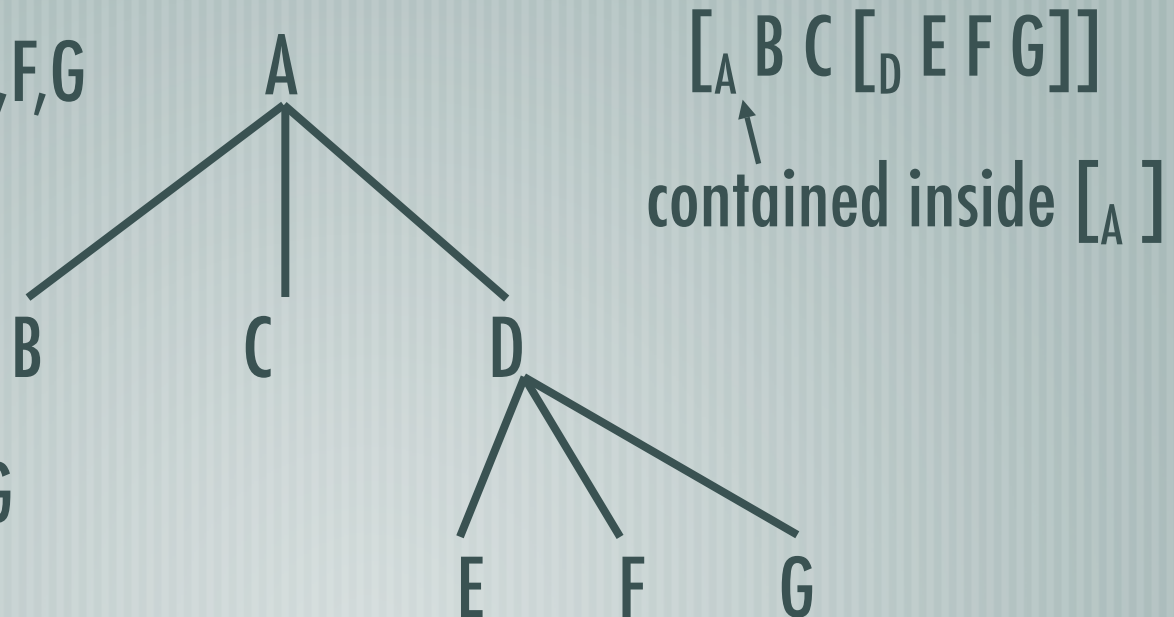
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Domination

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D dominates E,F,G

Another way to think of it: "on top of"

Domination

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— [A slightly more formal definition:

— **Domination:** Node A dominates node B if and only if A is higher up in the tree than B and if you can trace a line from A to B going only downwards.

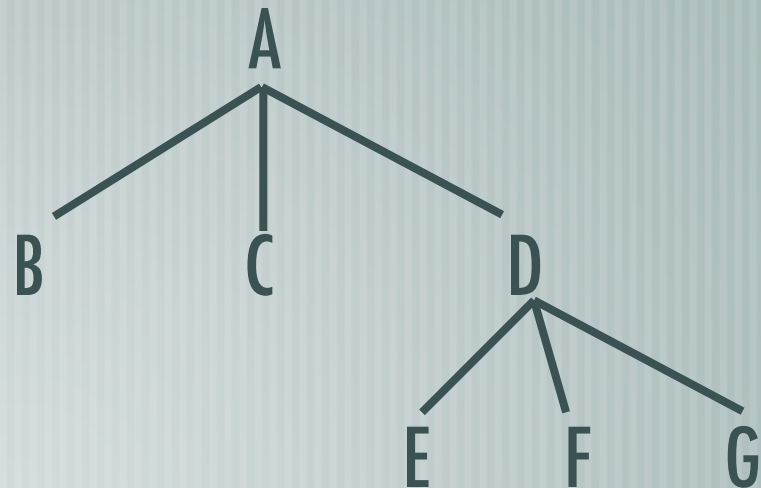
Immediate Domination

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— [Node A **immediately dominates** node B if there is no intervening node G which is dominated by A, but dominates B. (in other words, A is the first node that dominates B)]

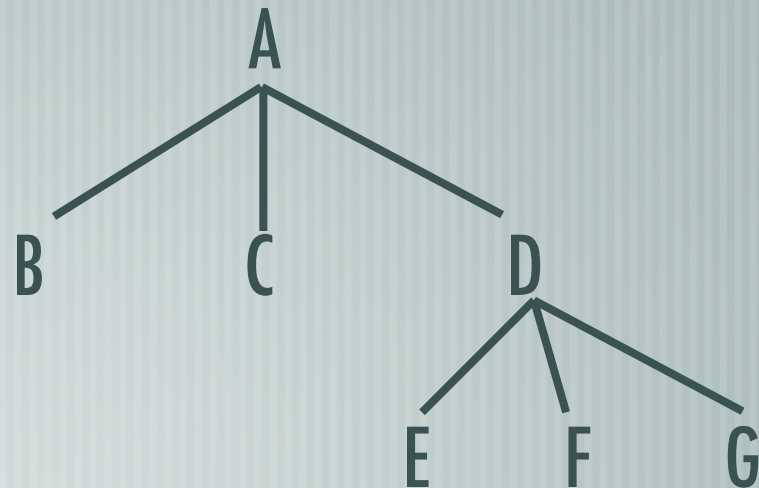
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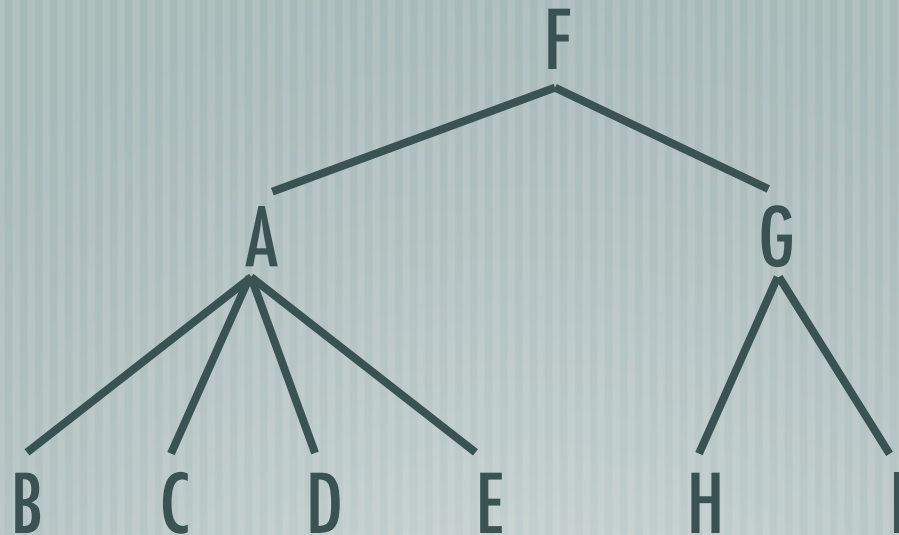
A dominates B,C,D,E,F,G

but A immediately dominates only B,C,D

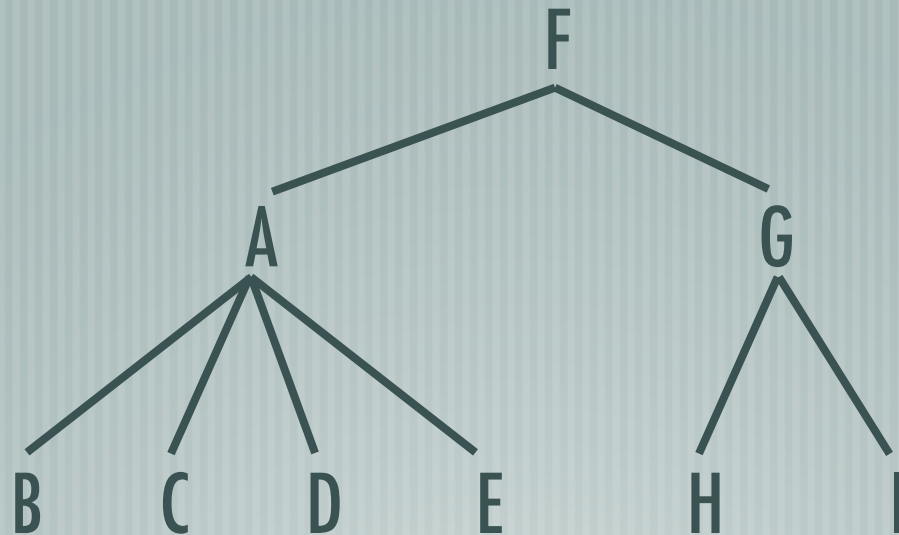
Exhaustive Domination

- [Node A exhaustively dominates a **SET** of **TERMINAL** nodes $\{B, C, \dots, D\}$,
 - provided it dominates all the members of the set (so that there is no member of the set that is not dominated by A)
 - AND there is no terminal node G dominated by A that is not a member of the set.

Exhaustive Domination

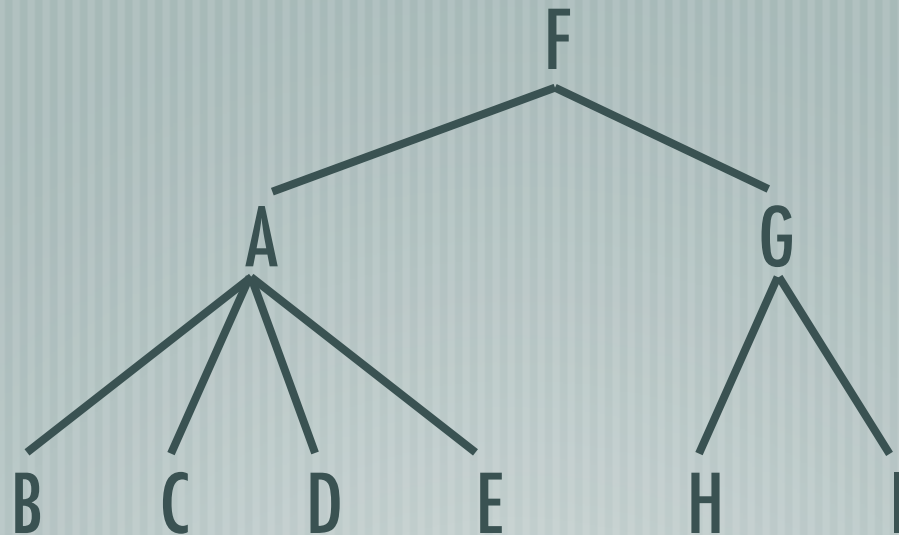


Exhaustive Domination



A exhaustively dominates the set {B,C,D,E}

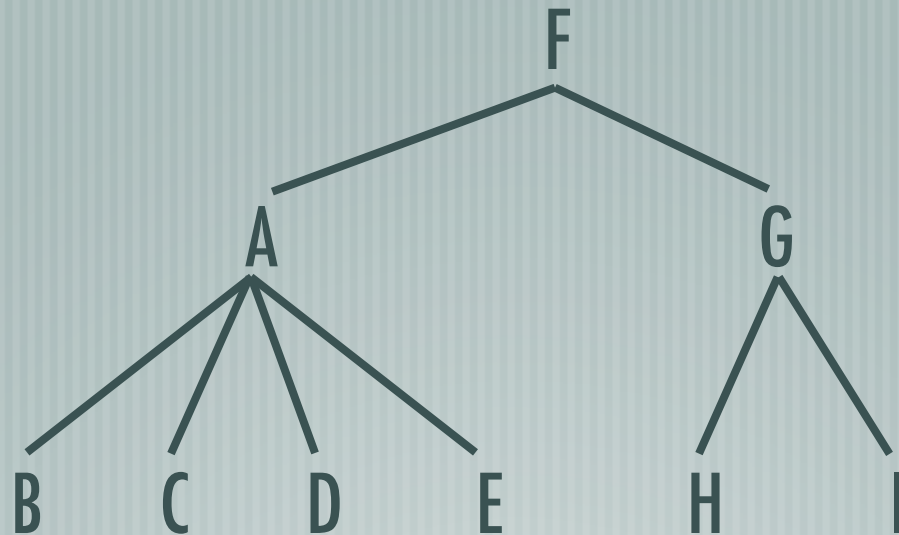
Exhaustive Domination



A exhaustively dominates the set $\{B, C, D, E\}$

A does **NOT** exhaustively dominate the set $\{B, C, D\}$

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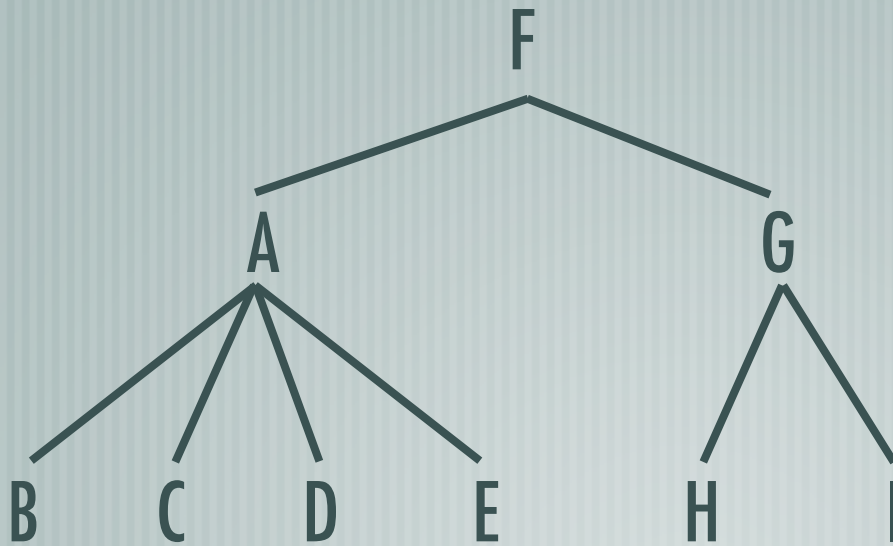
A formal definition of constituency

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— [**Constituent:** The set of nodes exhaustively dominated by a single node

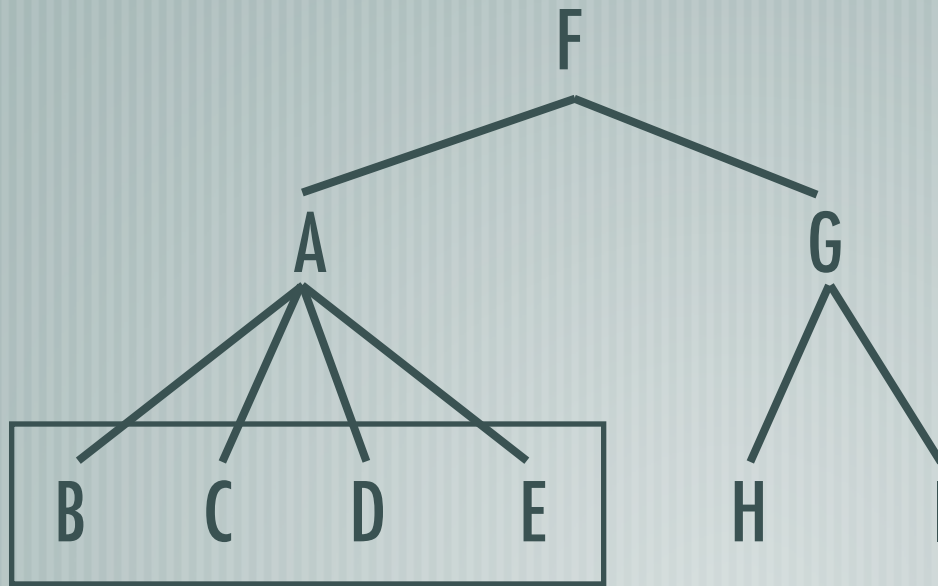
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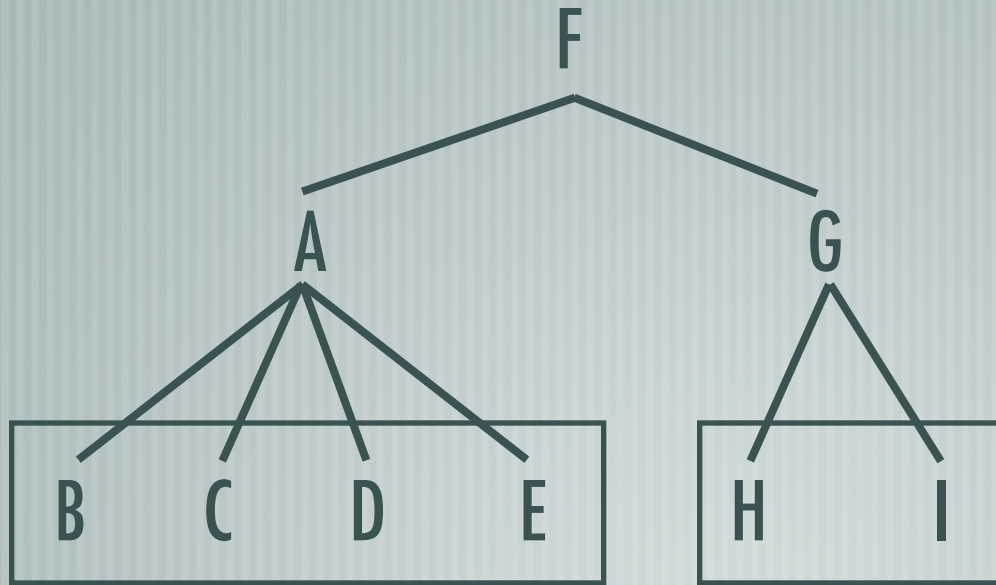
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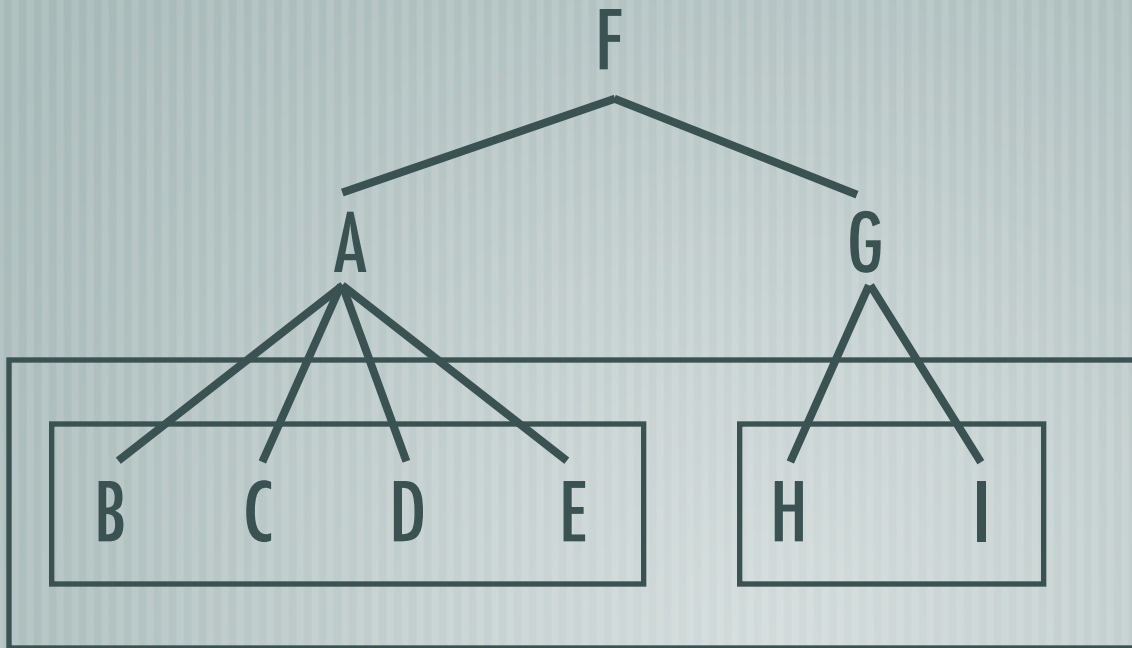
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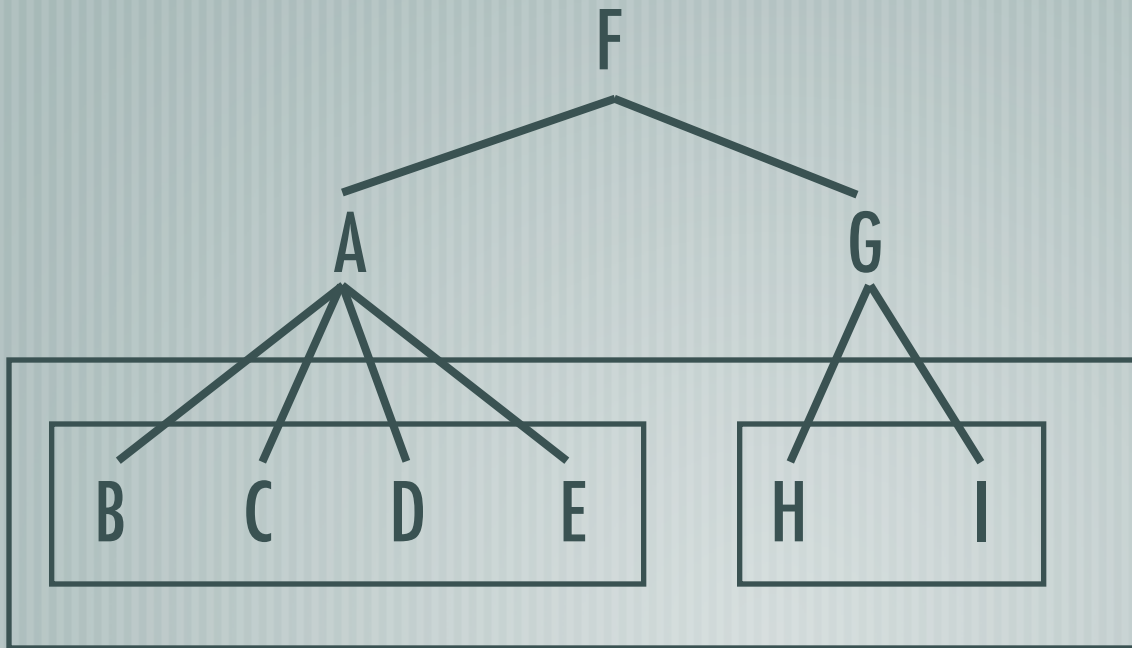
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{E, H} are NOT a constituent

Constituent vs Constituent of

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— [**immediate constituent of** is the opposite of immediate domination.

Some Informal Terms

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— [**Mother:** the node that immediately dominates another.

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- [**Mother:** the node that immediately dominates another.
- [**Daughter:** the node that is immediately dominated by another (is an immediate constituent of another).

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- [**Mother:** the node that immediately dominates another.
- [**Daughter:** the node that is immediately dominated by another (is an immediate constituent of another).
- [**Sisters:** two nodes that share the same mother.

Root and Terminal Nodes

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— [**Root node:** A node with no mother

Root and Terminal Nodes

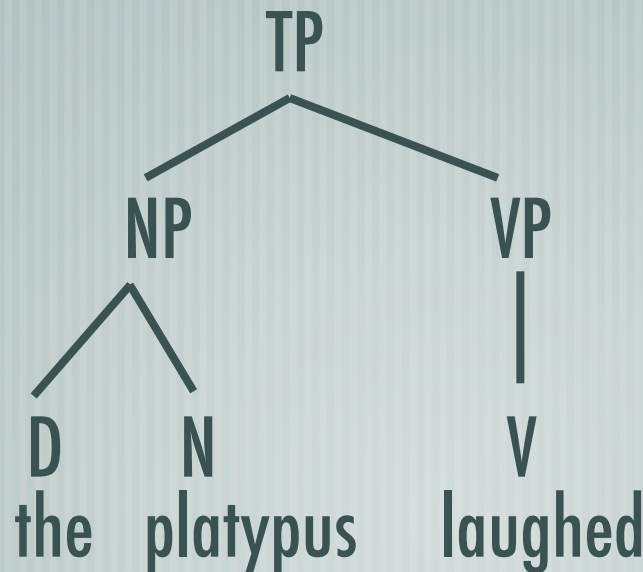
— [**Root node:** A node with no mother

— [**Terminal node:** A node with no daughters

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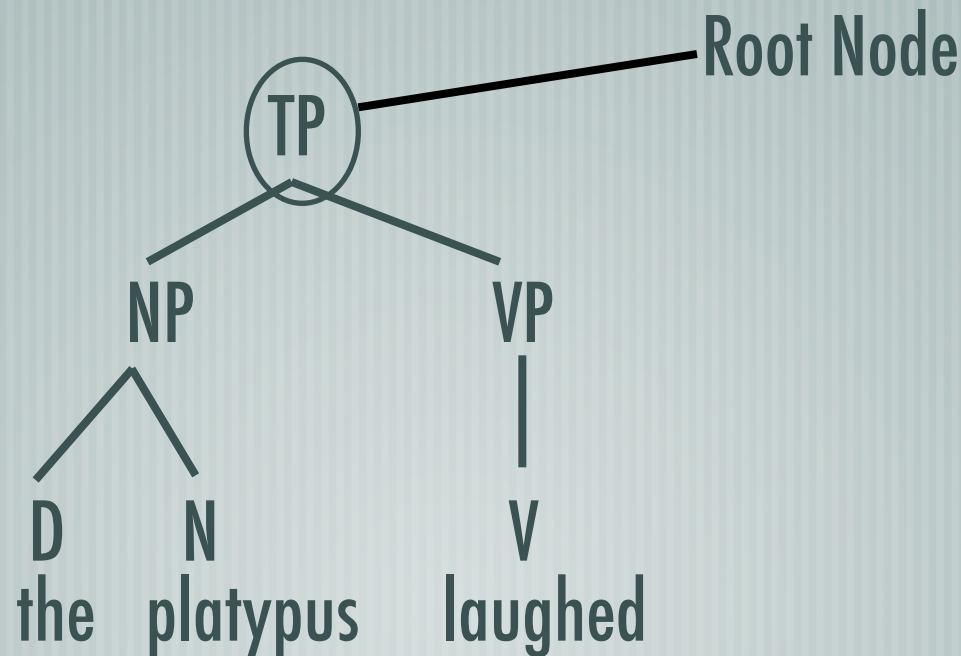
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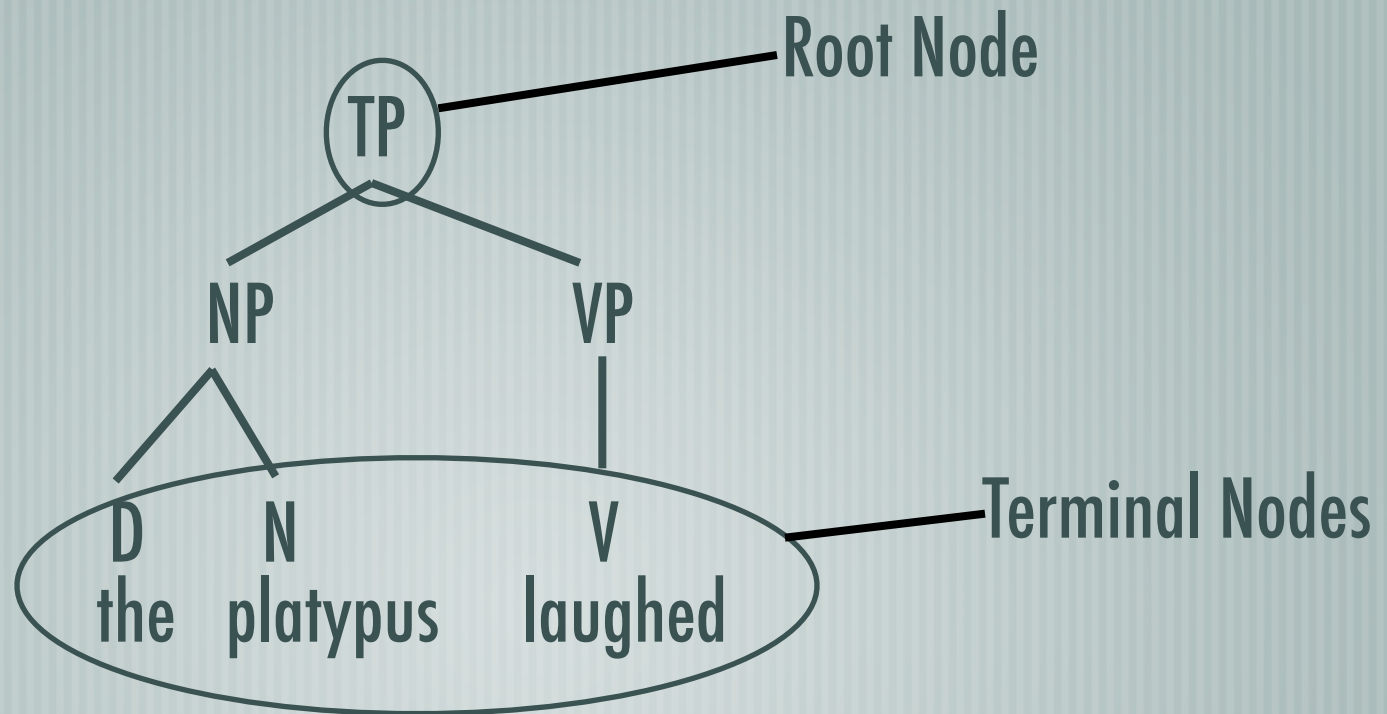
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Precedence

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- [**But this runs into problems with trees which are badly drawn**

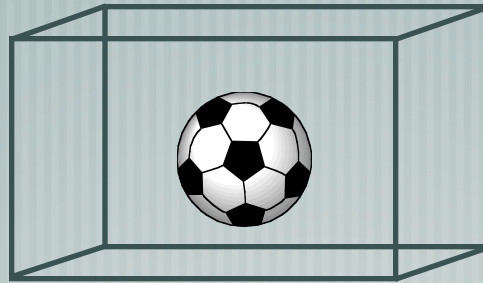
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— [Note that if two nodes are in a domination relation they cannot be in a precedence relation

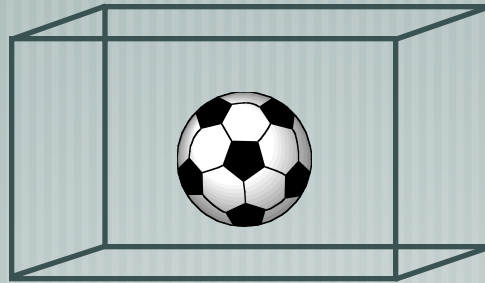
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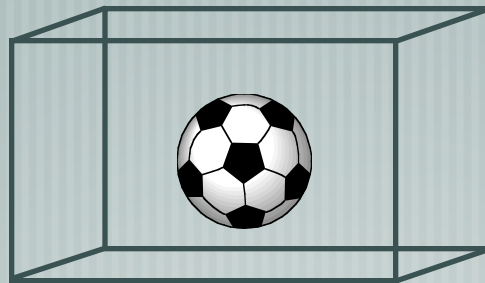
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Is the ball to the left or right of the box?

Precedence excludes domination

— [Note that if two nodes are in a domination relation they cannot be in a precedence relation



Is the ball to the left or right of the box?

Neither! You can't precede or follow something that dominates (contains) you or you dominate (contain).

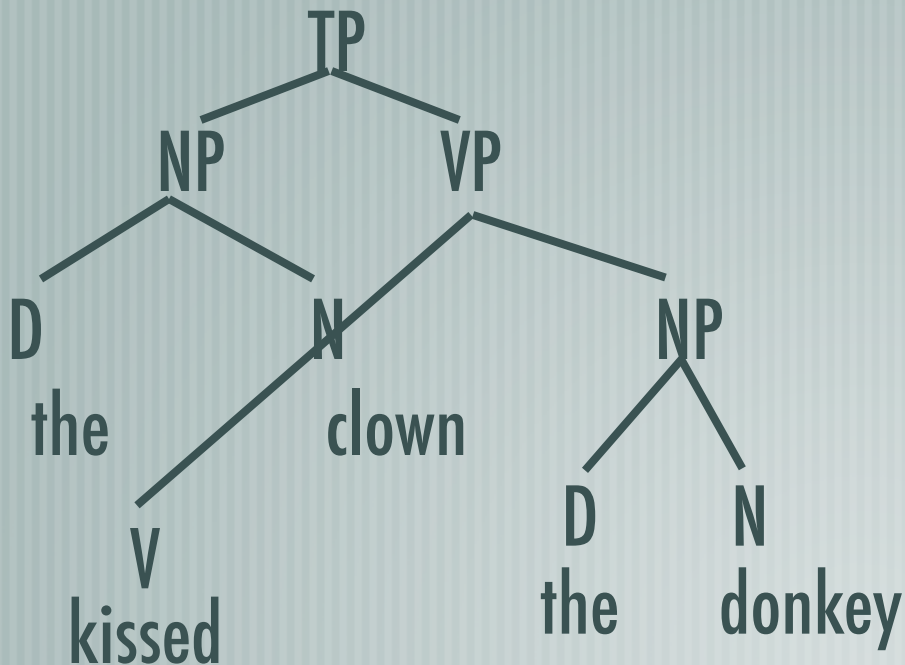
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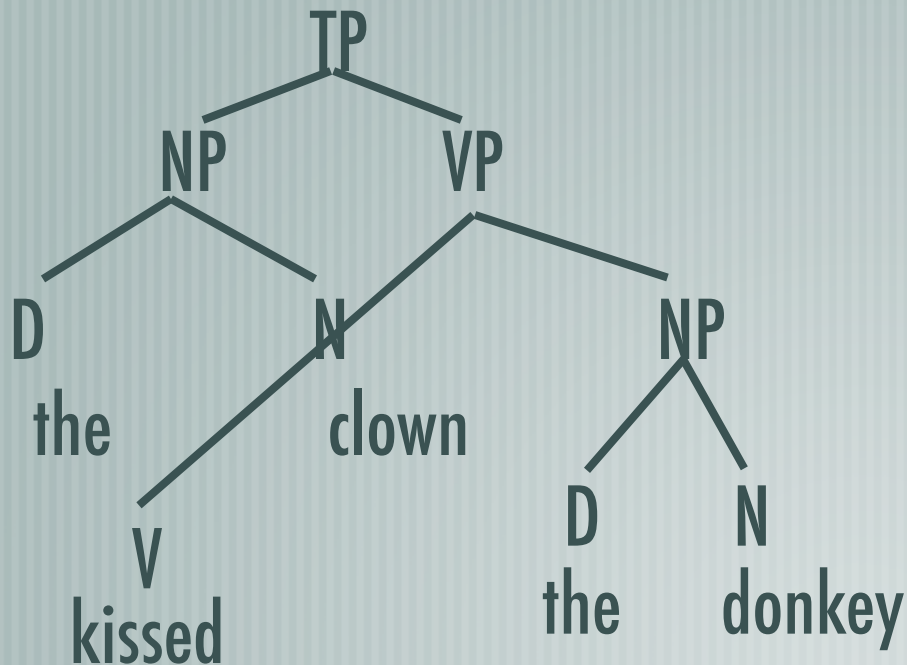
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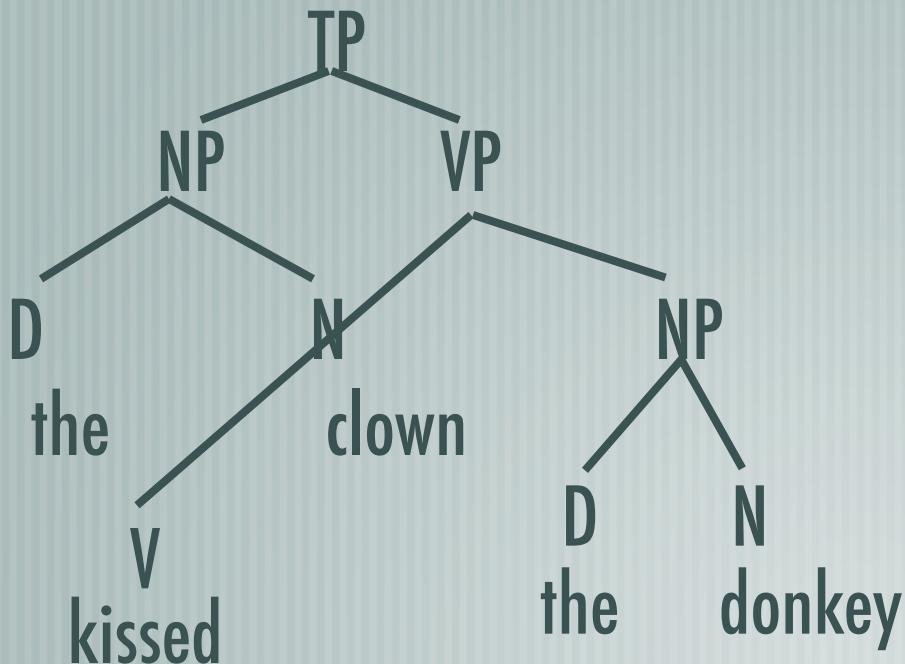
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Does kiss precede clown?
Obviously not!

Precedence

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Does kiss precede clown?
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What is crucial here is that
the dominator of clown
precedes the dominator of
kissed

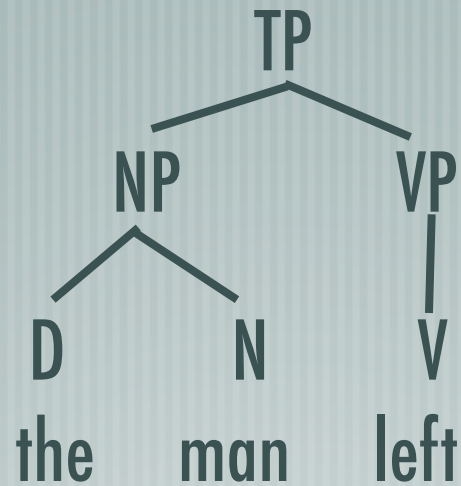
Sister-Precedence

— [In order to define precedence we're going to need a more local relation that refers to dominance. This is sister-precedence:

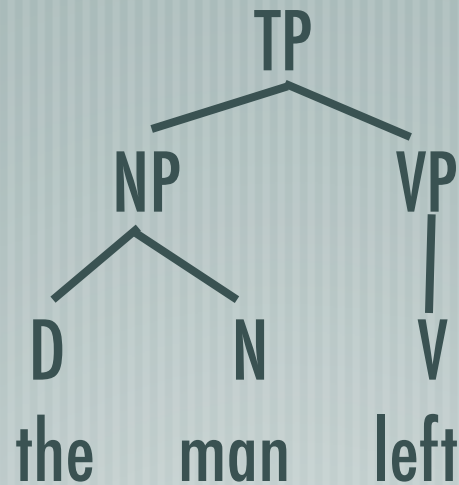
— [**A sister-precedes B** if and only if

- A and B are immediately dominated by the same node
- A appears to the left of B

Sister-Precedence

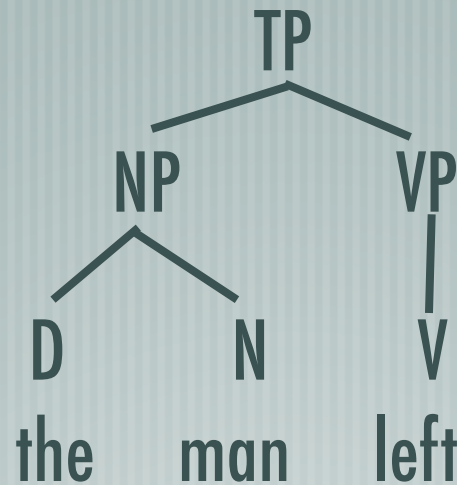


Sister-Precedence



NP sister-precedes VP

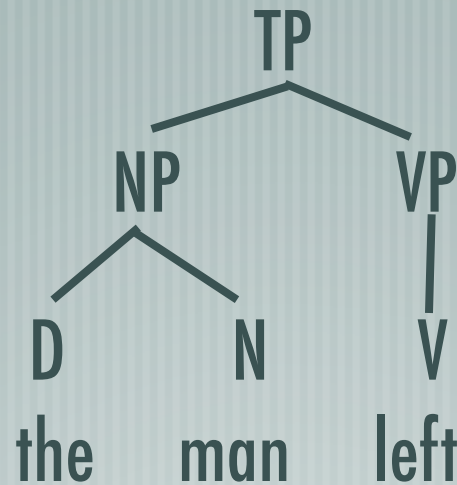
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Sister-Precedence



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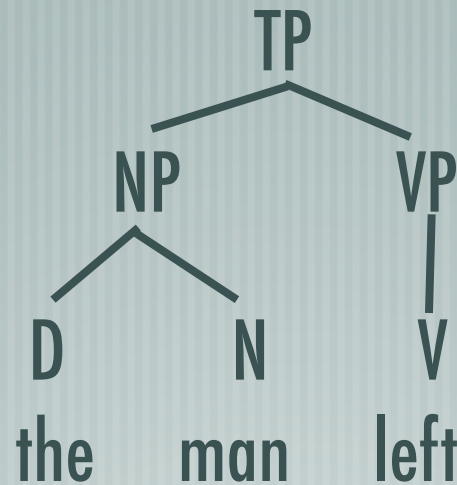
D sister precedes N

N does NOT sister precede V (nor does D)

Precedence

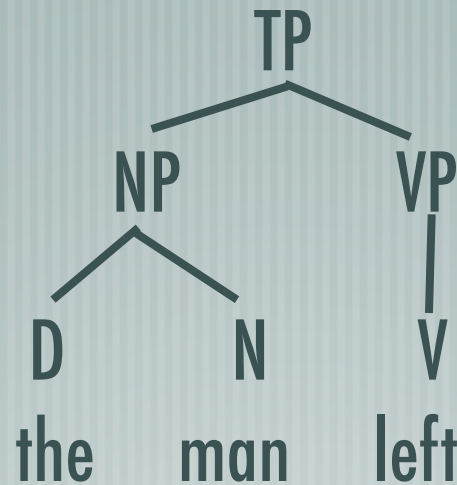
- [A Precedes B if and only iff
 - A does not dominate B and B does not dominate A AND
 - Either:
 - A sister-precedes B OR
 - There is some node E that dominates A, and some node F that dominates B, and E sister-precedes F.

Sister-Precedence $\neq$ Immediate Precedence



But N does immediately precede V

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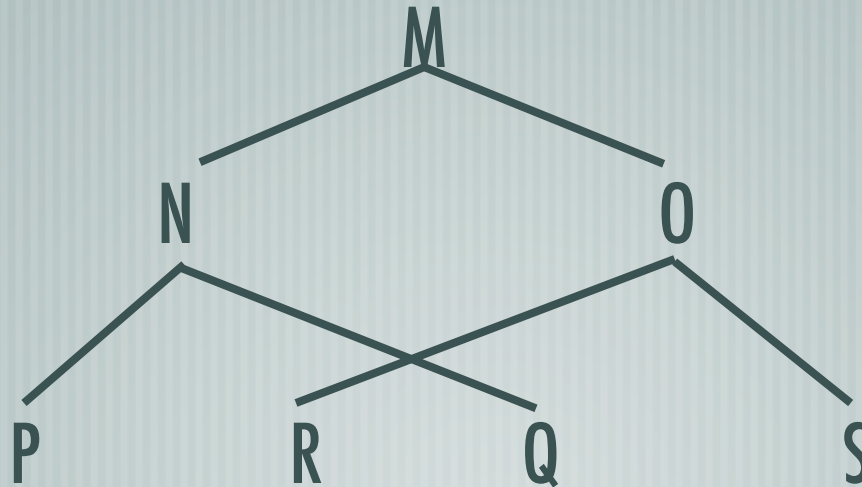


N does NOT sister-precede V

But N does immediately precede V

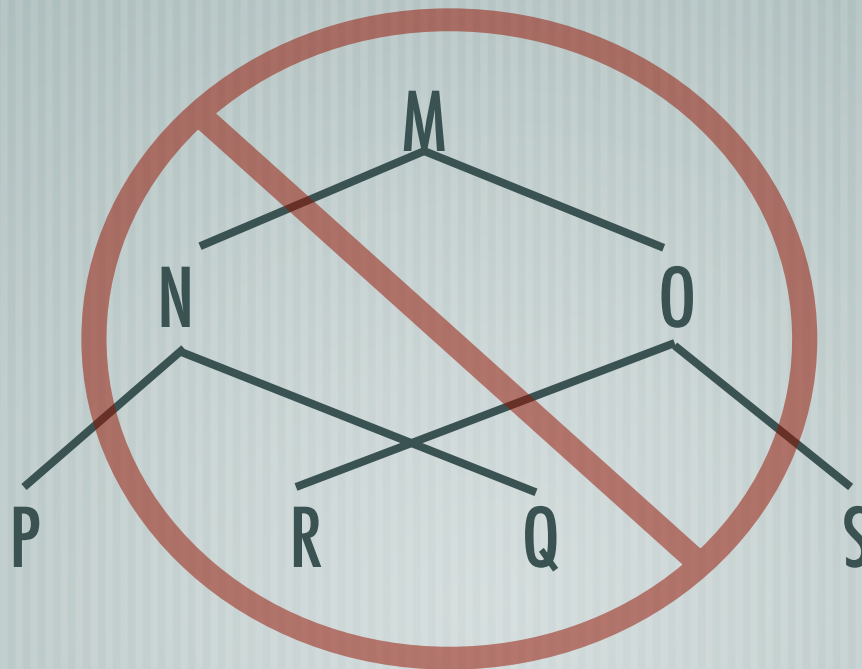
No Crossing Branches Constraint

— [If one node X precedes another node Y then X and all nodes dominated by X must precede Y and all nodes dominated by Y .



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- [**Immediate Precedence:**
 - A immediately precedes B if there is no node G which follows A but precedes B.

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A

B

G

Immediate Precedence

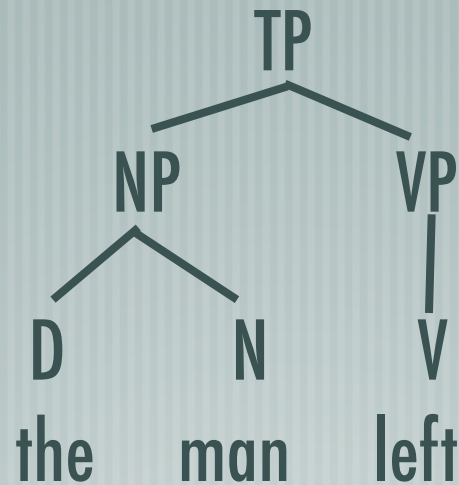
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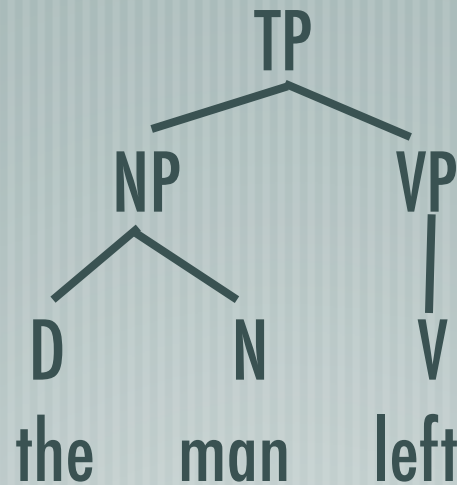
A G B

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- [Intuitively: The relationship between a node and its sister, and all the daughters of its sister

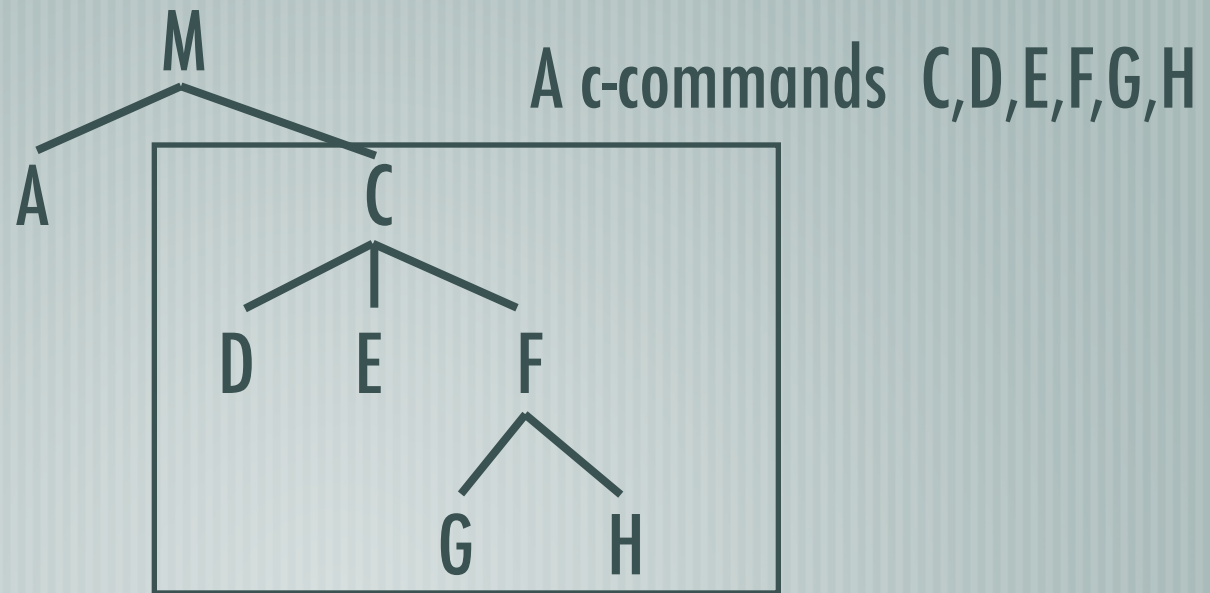
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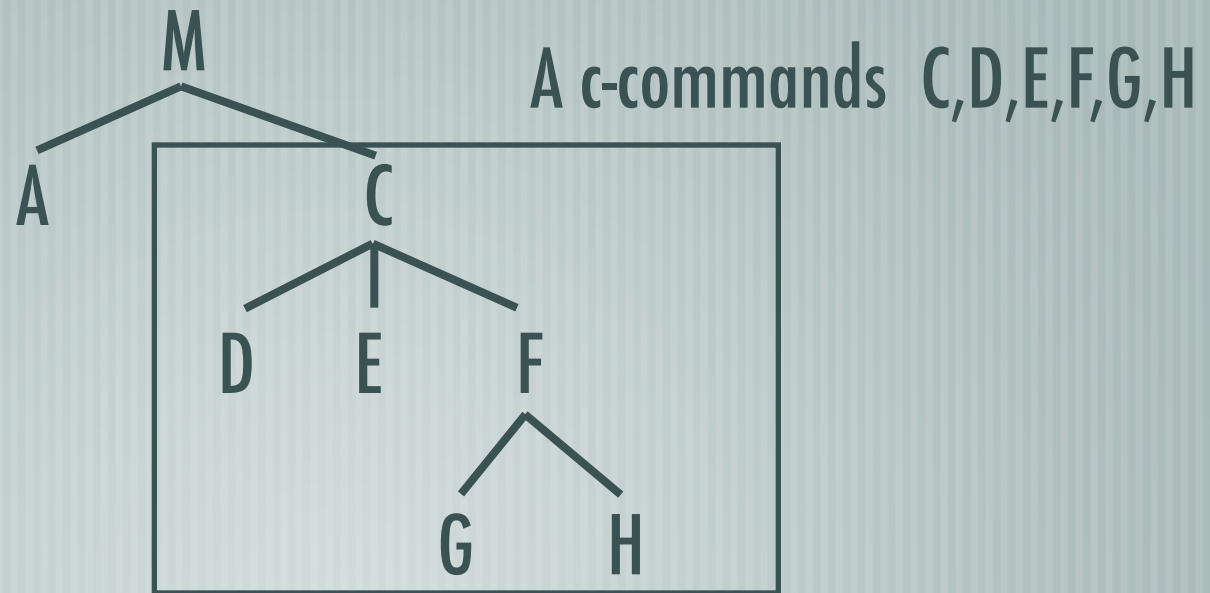
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Note: D does NOT c-command A

C-command

- [Node A **c-commands** node B if
- [every node dominating A also dominates B,
- [and A does not itself dominate B.

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- [Node A **c-commands** node B if
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- Sisterhood

C-command

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- you can't command something you dominate

Symmetric C-command

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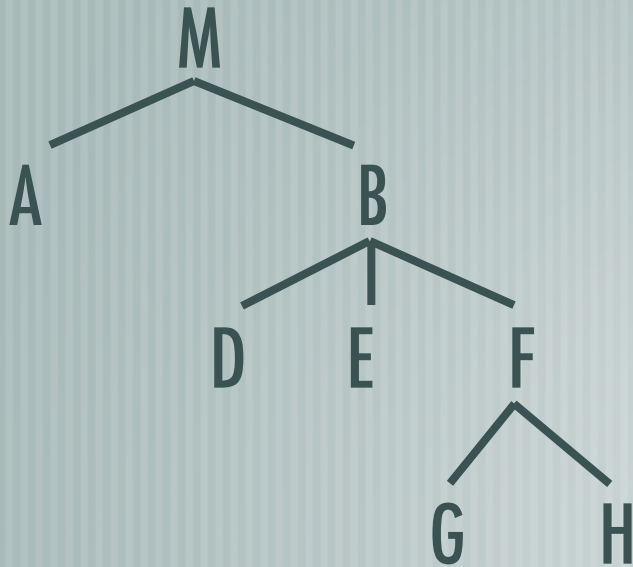
Symmetric C-command

- [**A symmetrically c-commands B, if A c-commands B AND B c-commands A**
- [**SAME THING AS SISTERHOOD**

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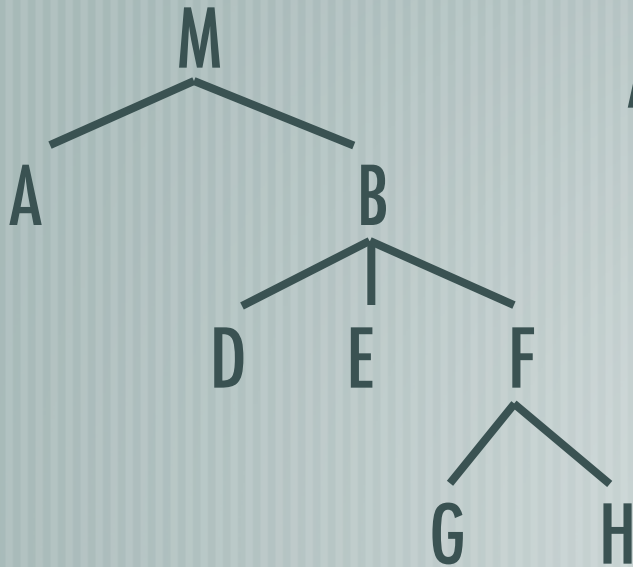


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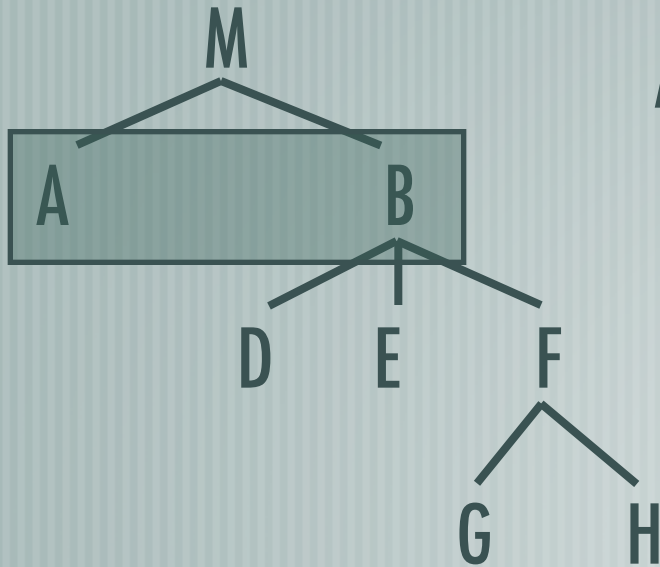
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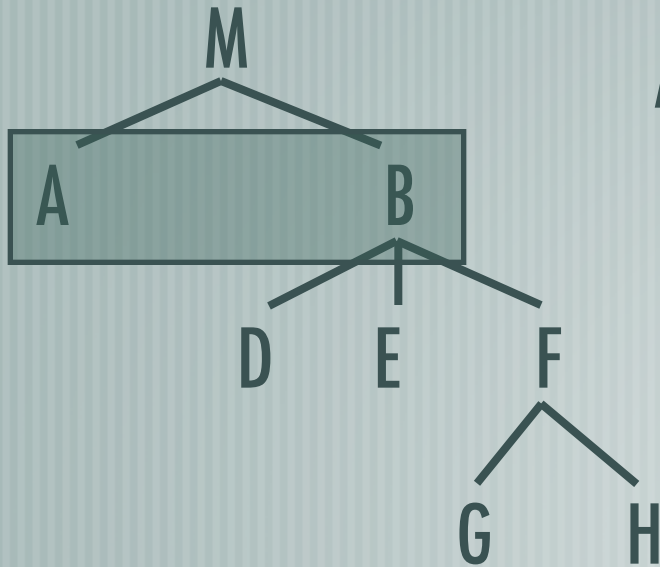


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A & B symmetrically c-command one another

A does NOT symmetrically c-command D

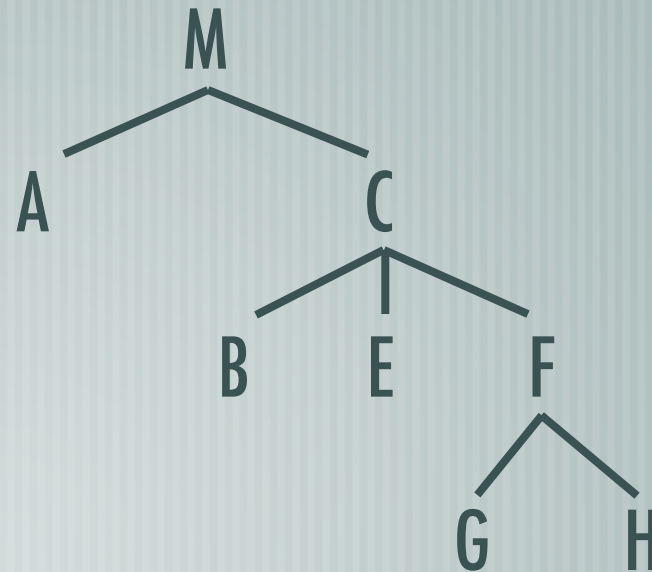
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- [A asymmetrically c-commands B, if A c-commands B but B does NOT c-command A.
 - (intuitively – A is B's aunt)

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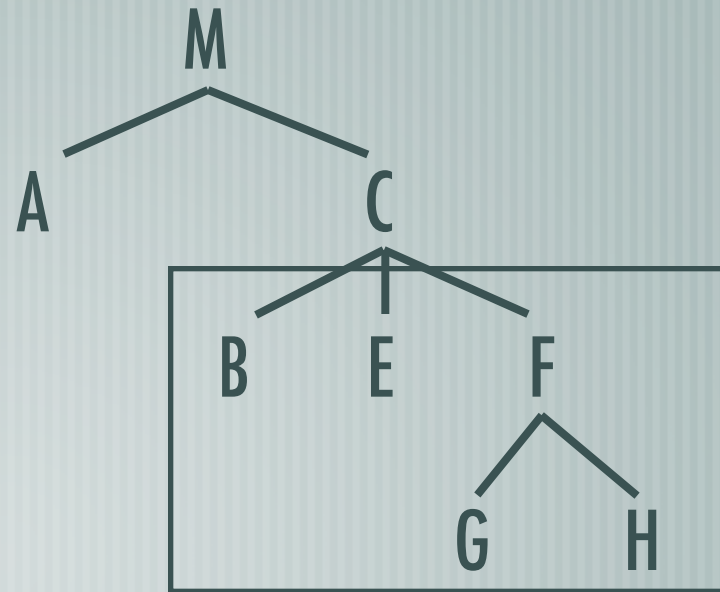
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Grammatical Relations

- [**Subject:** NP/CP daughter of TP

- [**Object of a Preposition:** NP daughter of PP

- [**Direct Object:**

- With verbs of type $V_{[NP_NP]}$, $V_{[NP_CP]}$ and $V_{[NP_NP\ PP]}$, the NP or CP daughter of VP

- With verbs of type $V_{[NP_NP\ \{NP/CP\}]}$, an NP or CP daughter of VP that is preceded by another NP daughter of VP. (i.e., the second NP daughter of VP)

Grammatical Relations

— [**Indirect Object:** This is the 1st object indicating the goal of a verb of transfer (a ditransitive) or the PP of the same kind of verb:

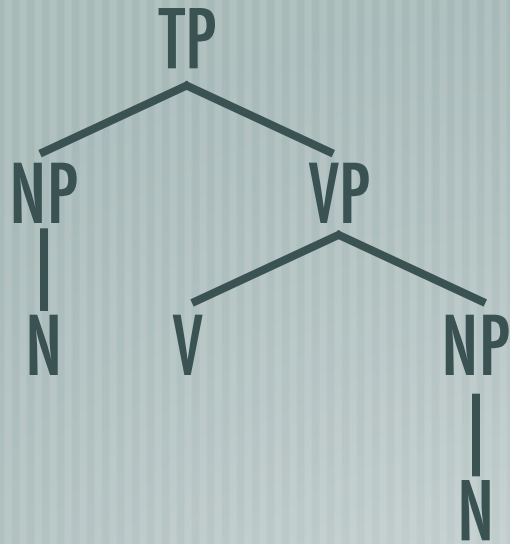
— With verbs of type $V_{[NP __ NP PP]}$, the PP daughter of VP immediately preceded by an NP daughter of VP.

— With verbs of type $V_{[NP __ NP \{NP/CP\}]}$, the NP daughter of VP immediately preceded by V (i.e. the first NP daughter of VP)

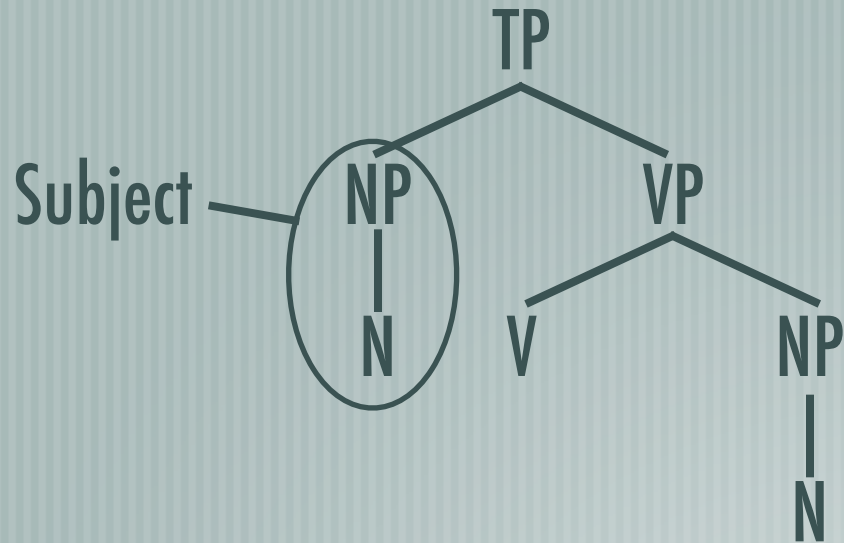
— [**Oblique:** any other NP/PP in the sentence.

Grammatical Relations

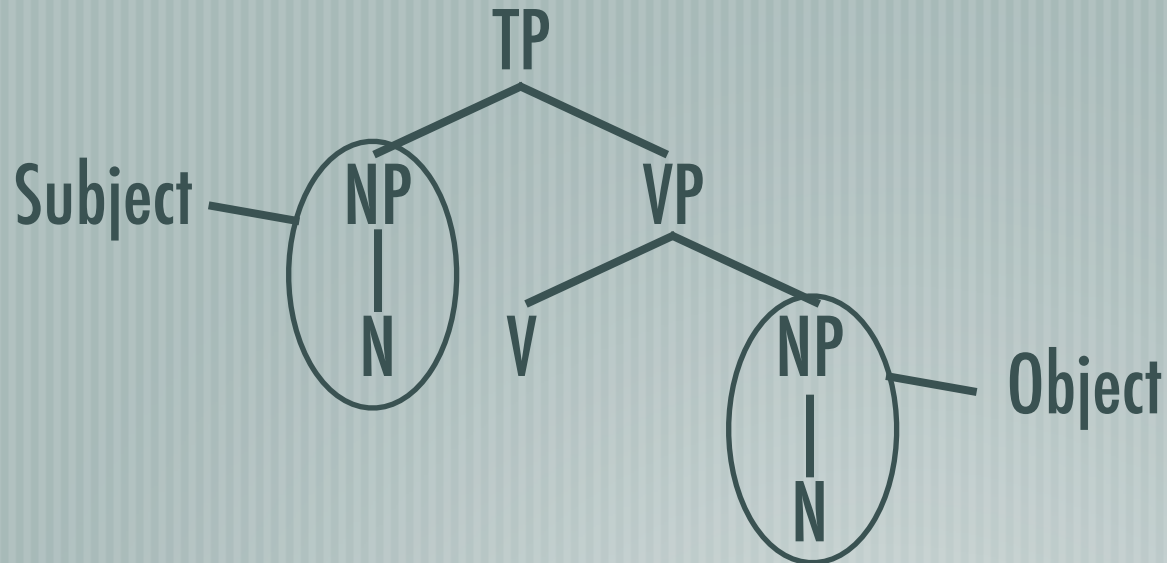
Grammatical Relations



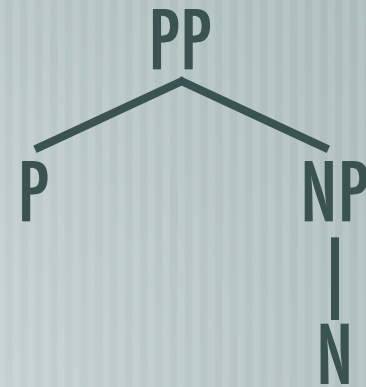
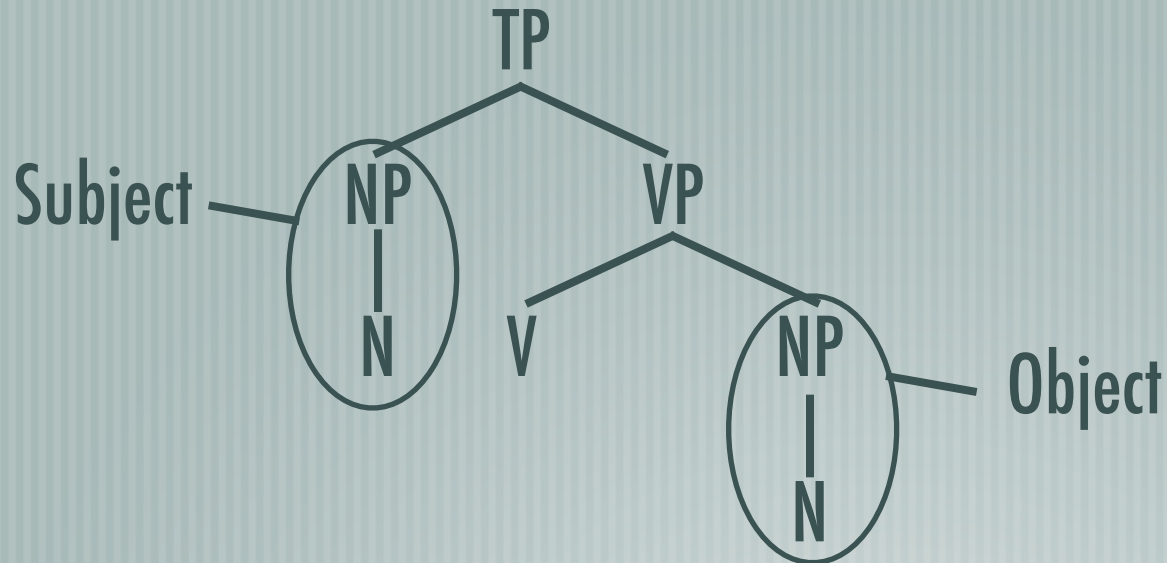
Grammatical Relations



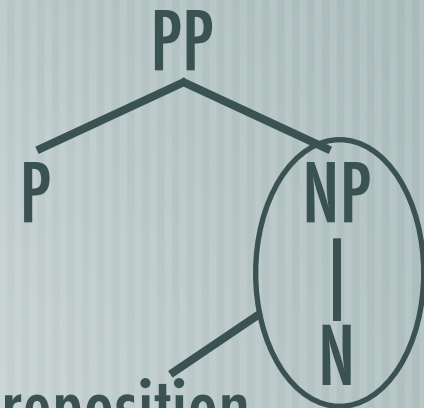
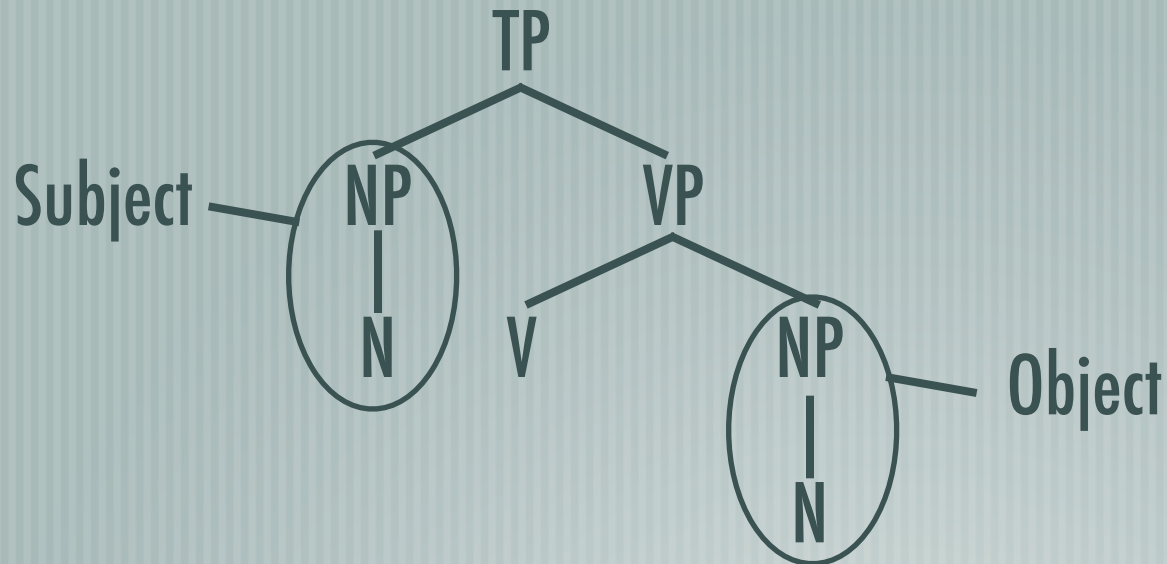
Grammatical Relations



Grammatical Relations



Grammatical Relations



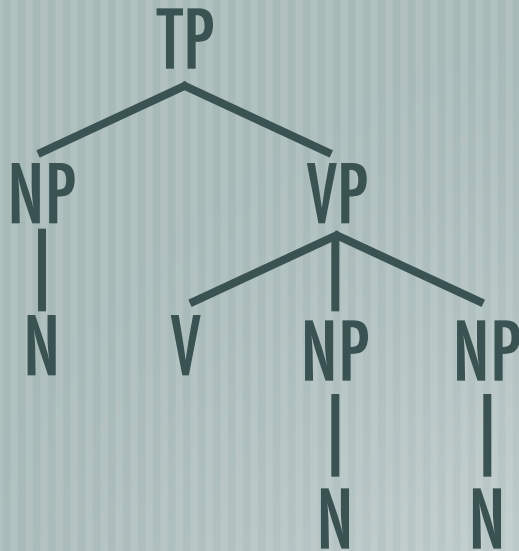
Object of a Preposition

Grammatical Relations

Grammatical Relations

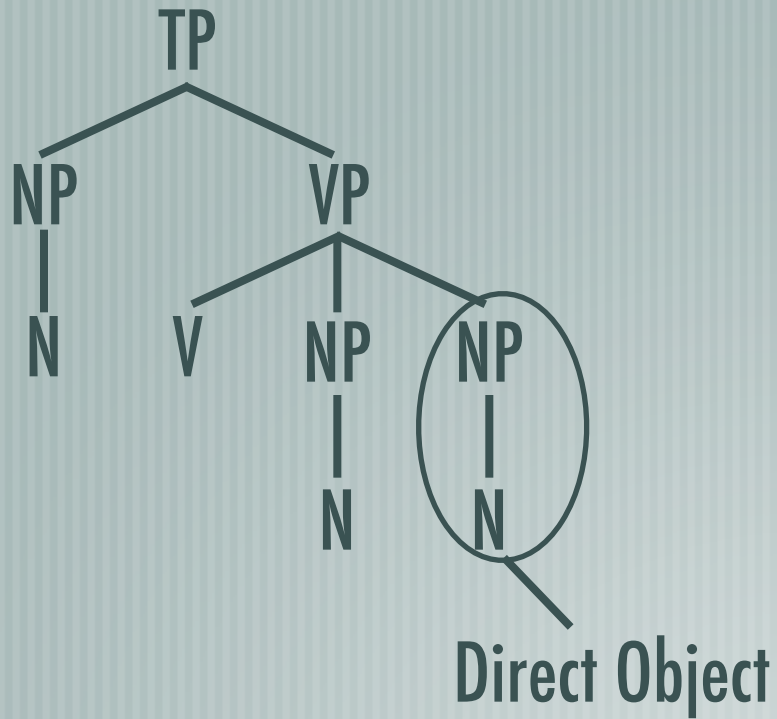
I gave Adam the book

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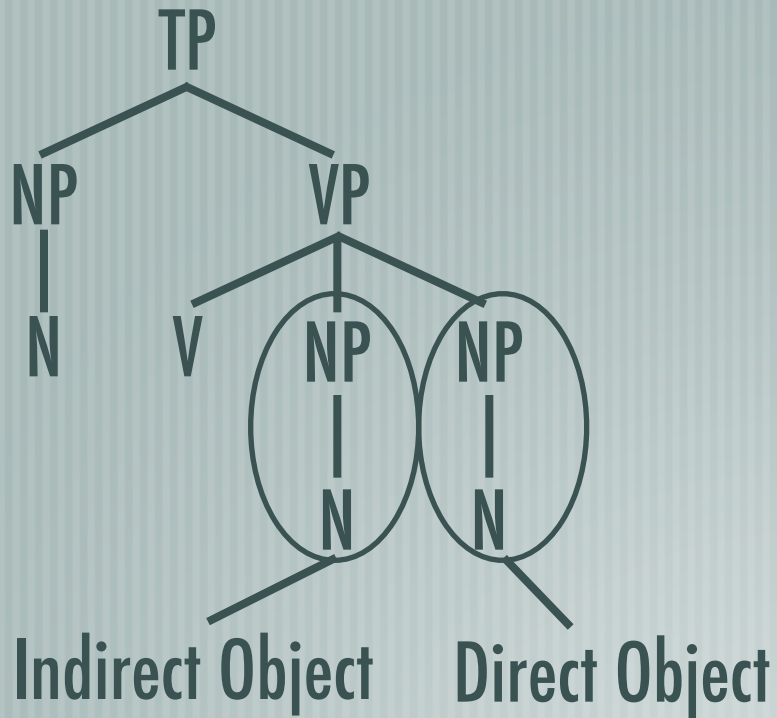
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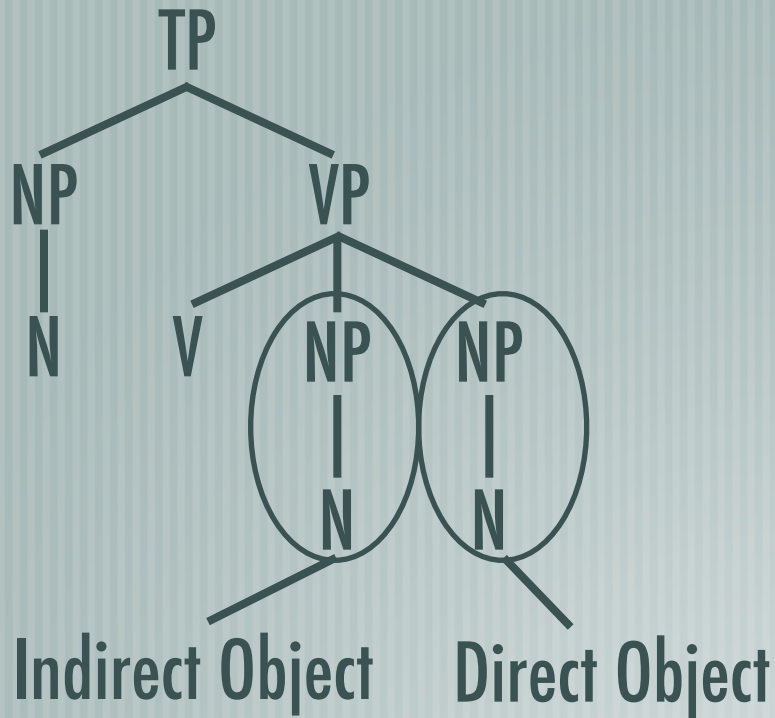
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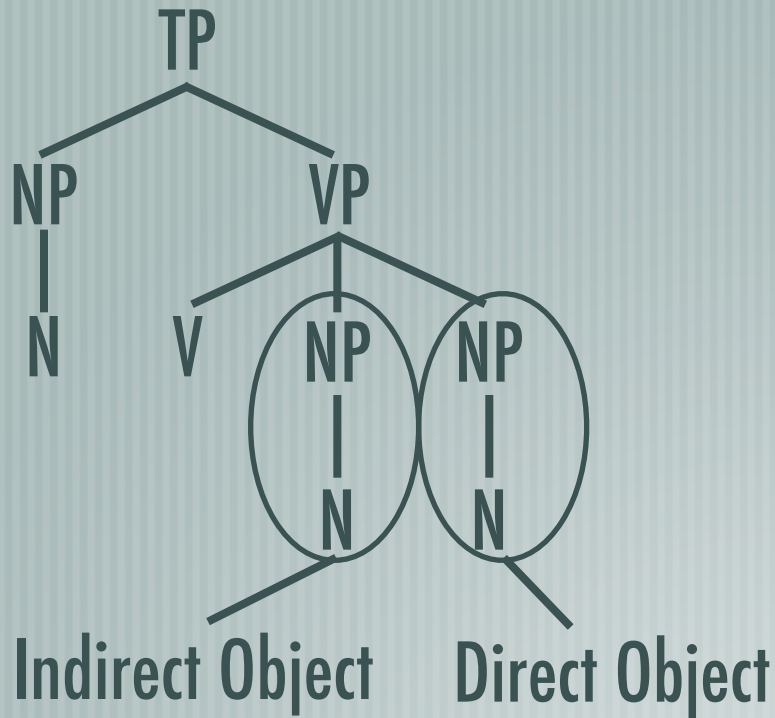
Grammatical Relations



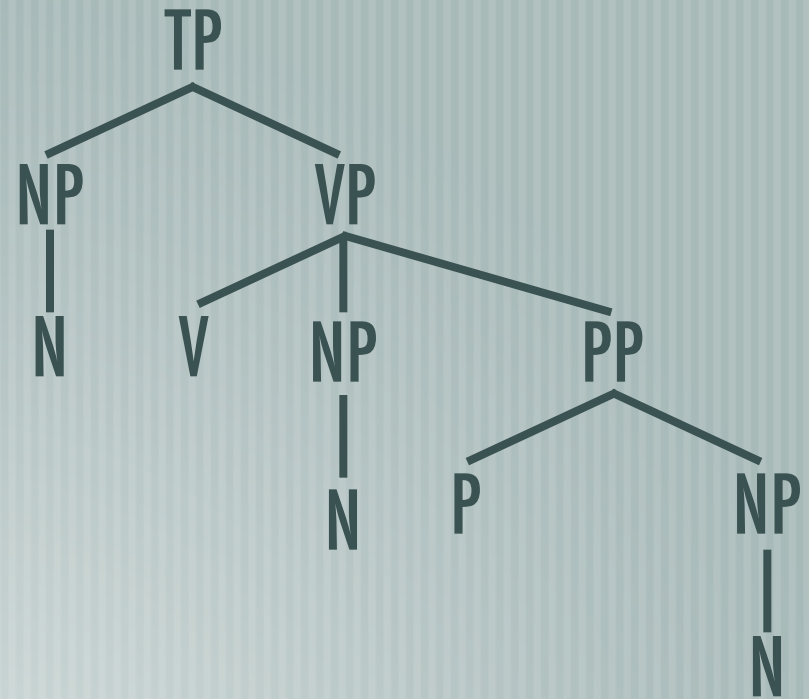
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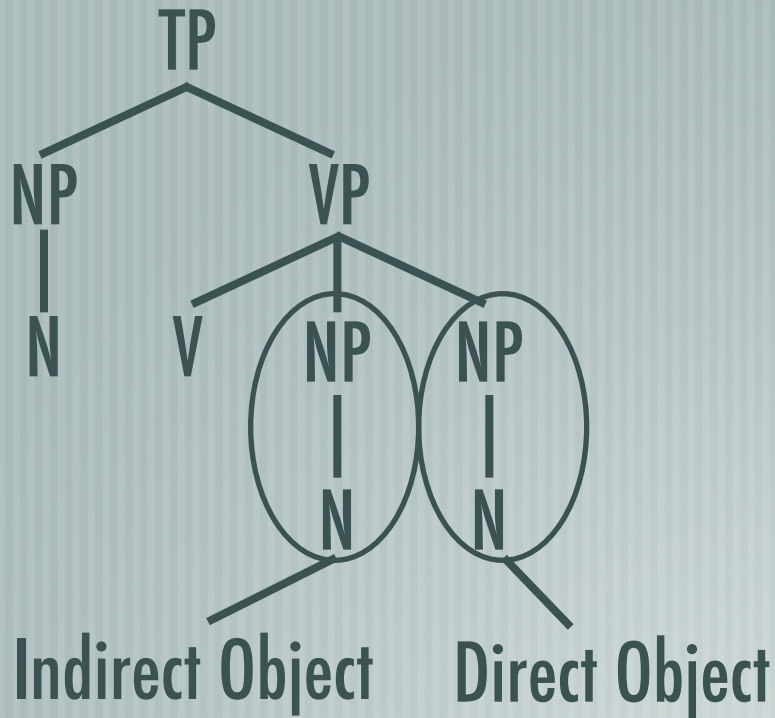


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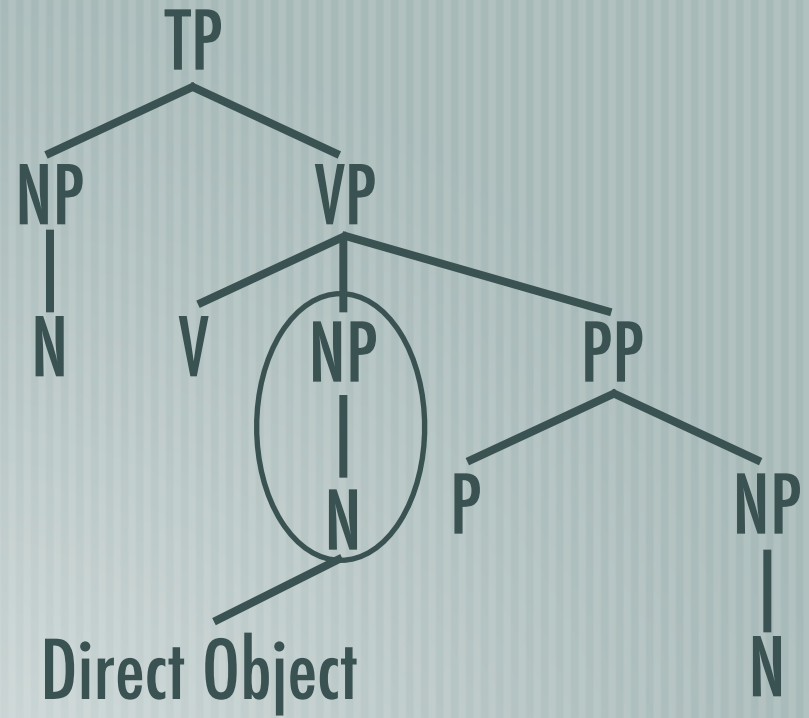


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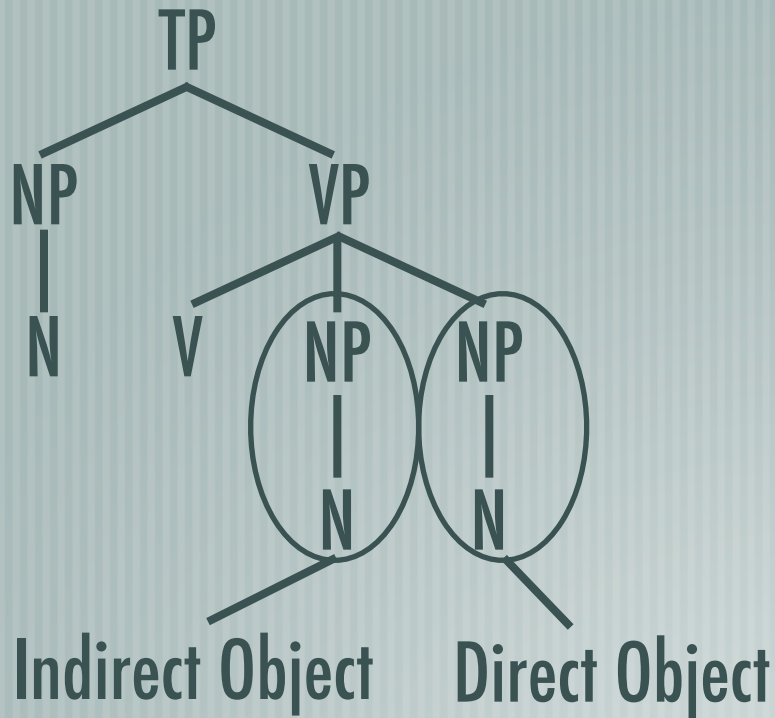


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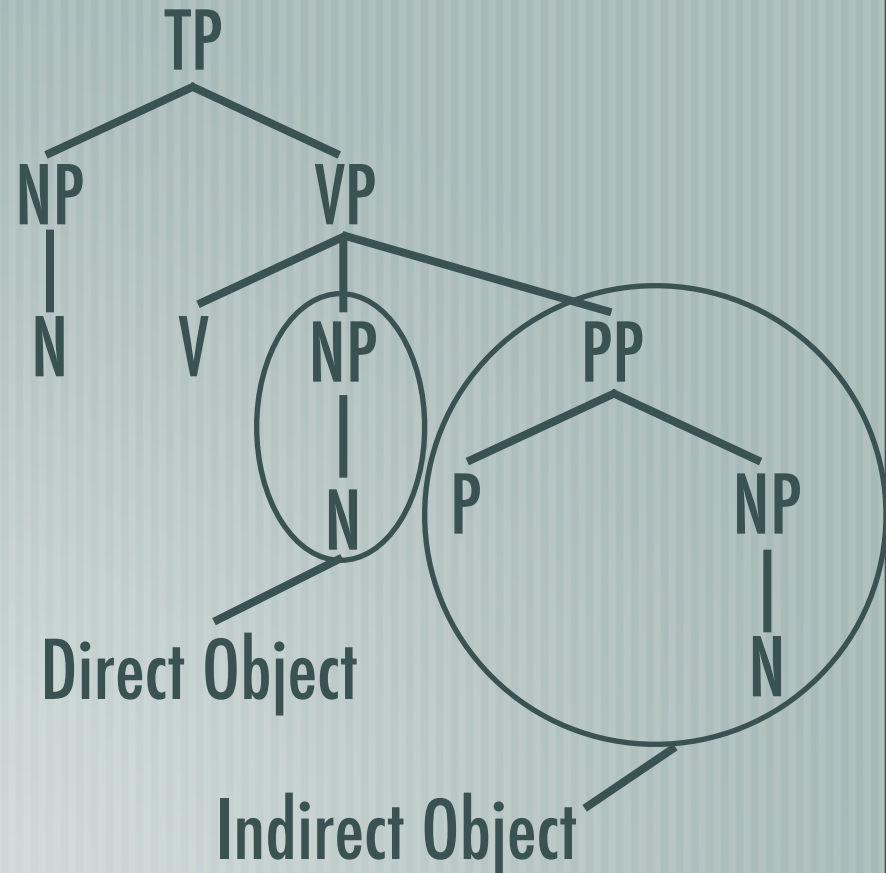


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Summary

- [**Structural Relations:** relationships between nodes.

- [**Dominance (=containment)**

- immediate dominance (=motherhood)

- exhaustive dominance (=constituent)

- [**Precedence ($\simeq$ to the left)**

- immediate precedence (=adjacent & to the left)

Summary

- [**C-command: sisters & nieces**

- Symmetric C-command: sisters

- Asymmetric C-command: Aunt asymmetrically c-commands nieces

- [**Grammatical Relations: Subject, Direct Object, Indirect Object, Object of a Preposition.**