Structural Relations

The mathematical properties of phrase structure trees

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Important!

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Important!

- 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.

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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!*

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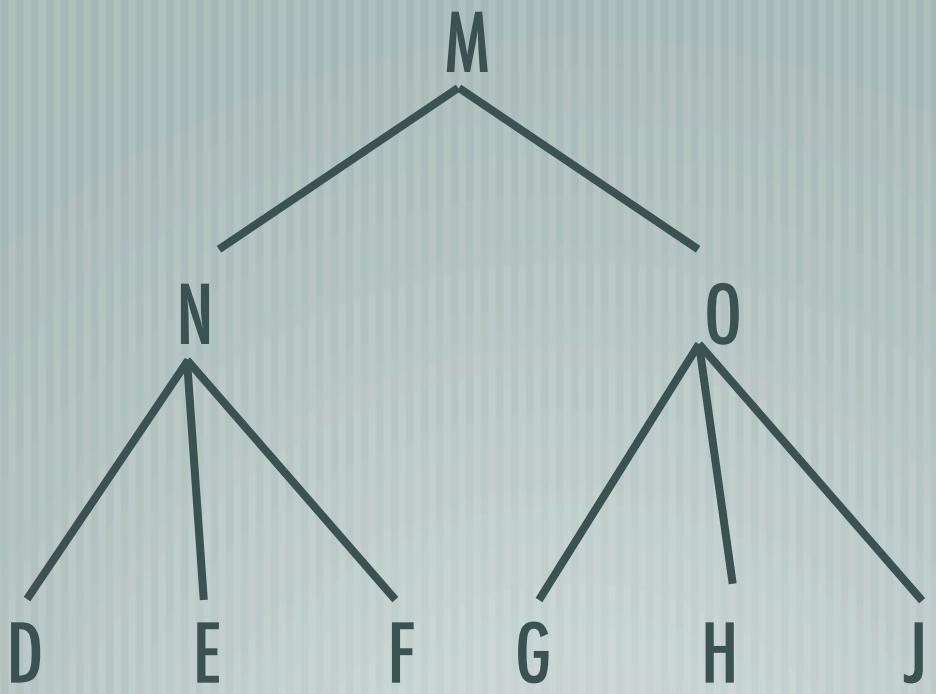
Some basic terms



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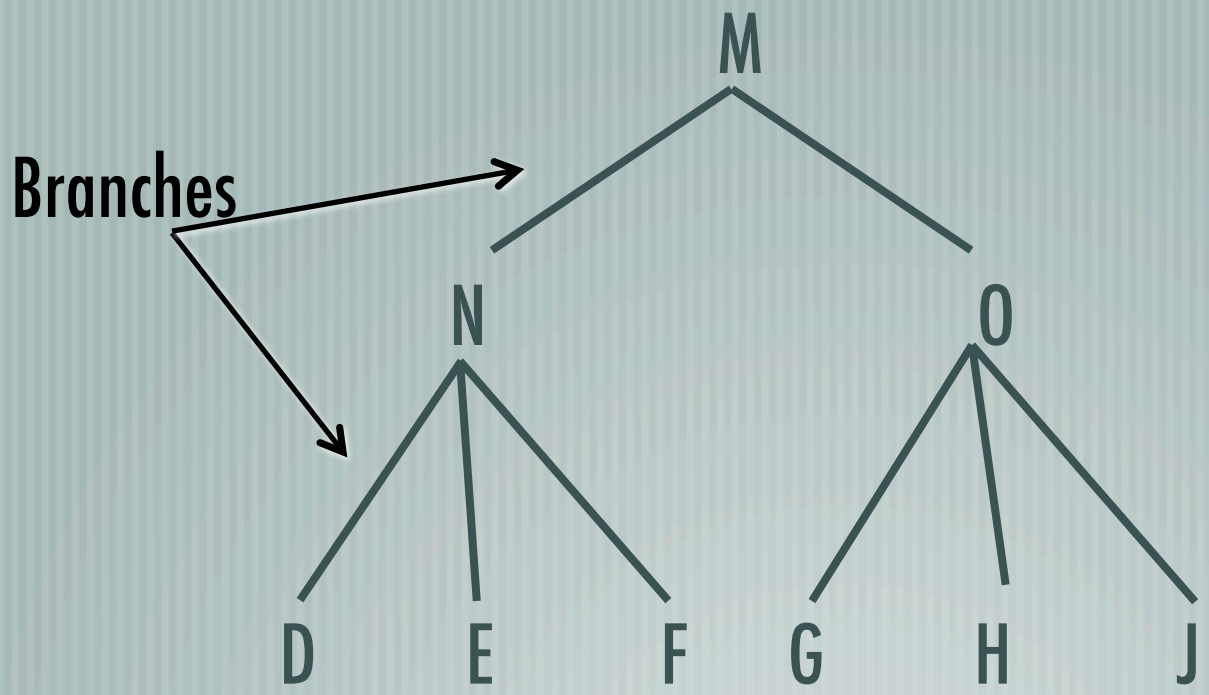

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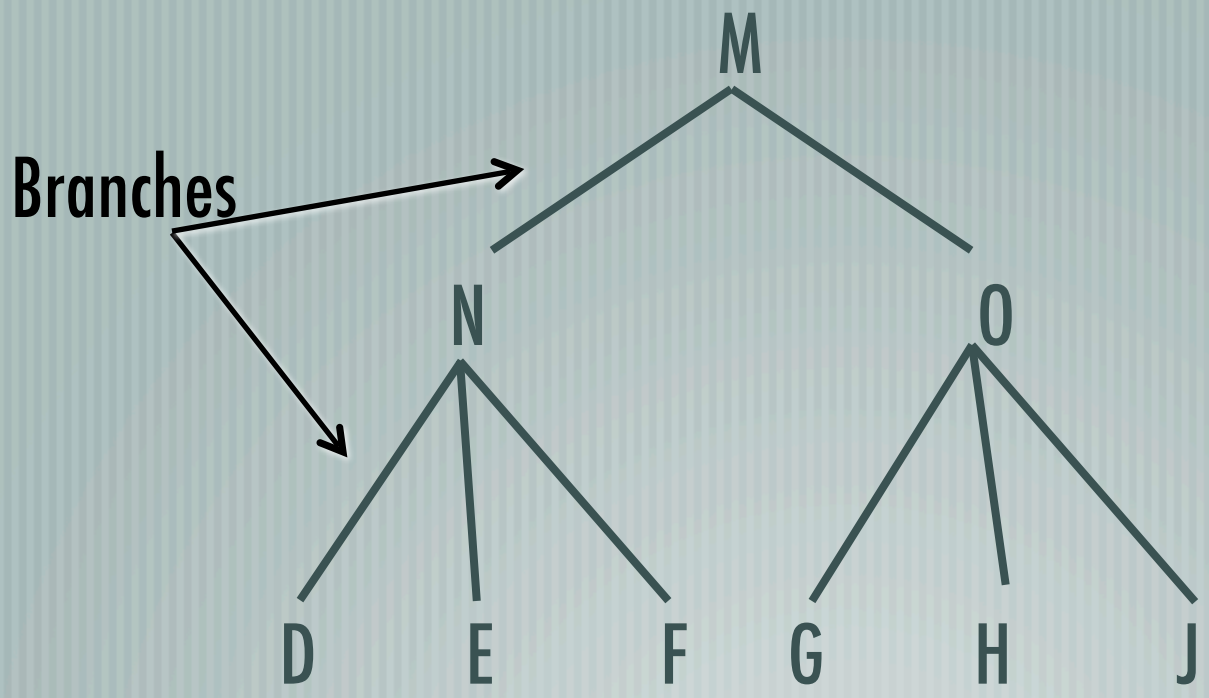

Labels: M,N,O,D,E,F,G,H,J

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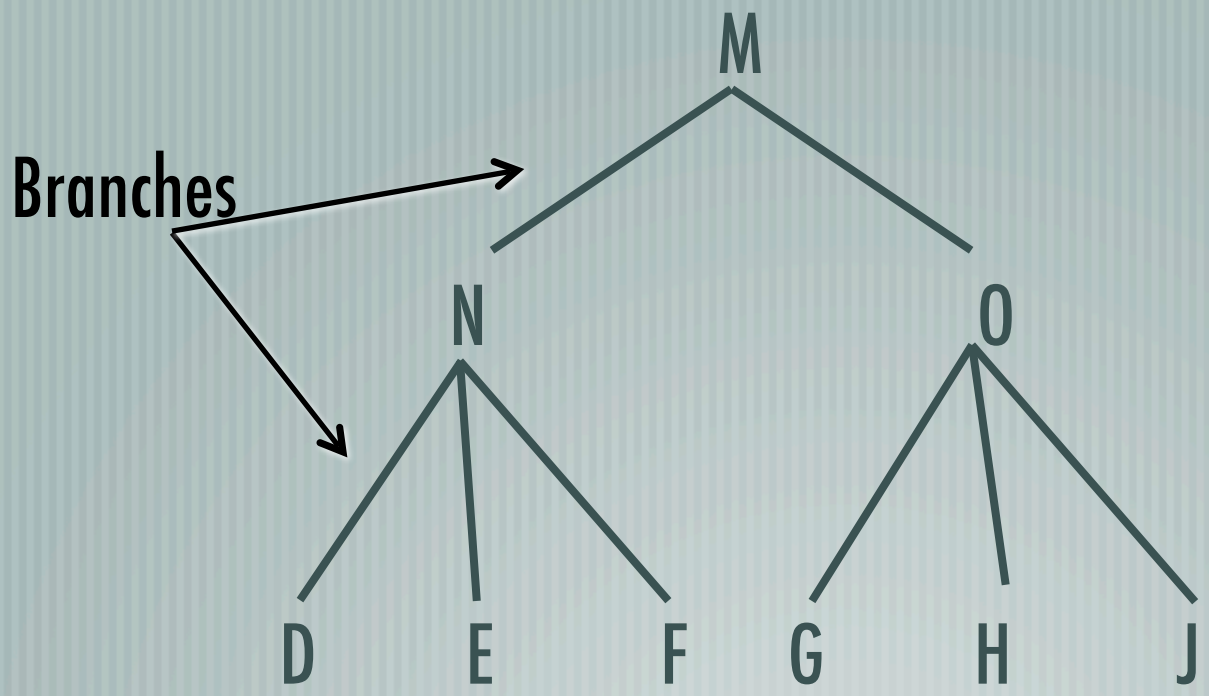

Labels: M,N,O,D,E,F,G,H,J

Node: Any point with a label

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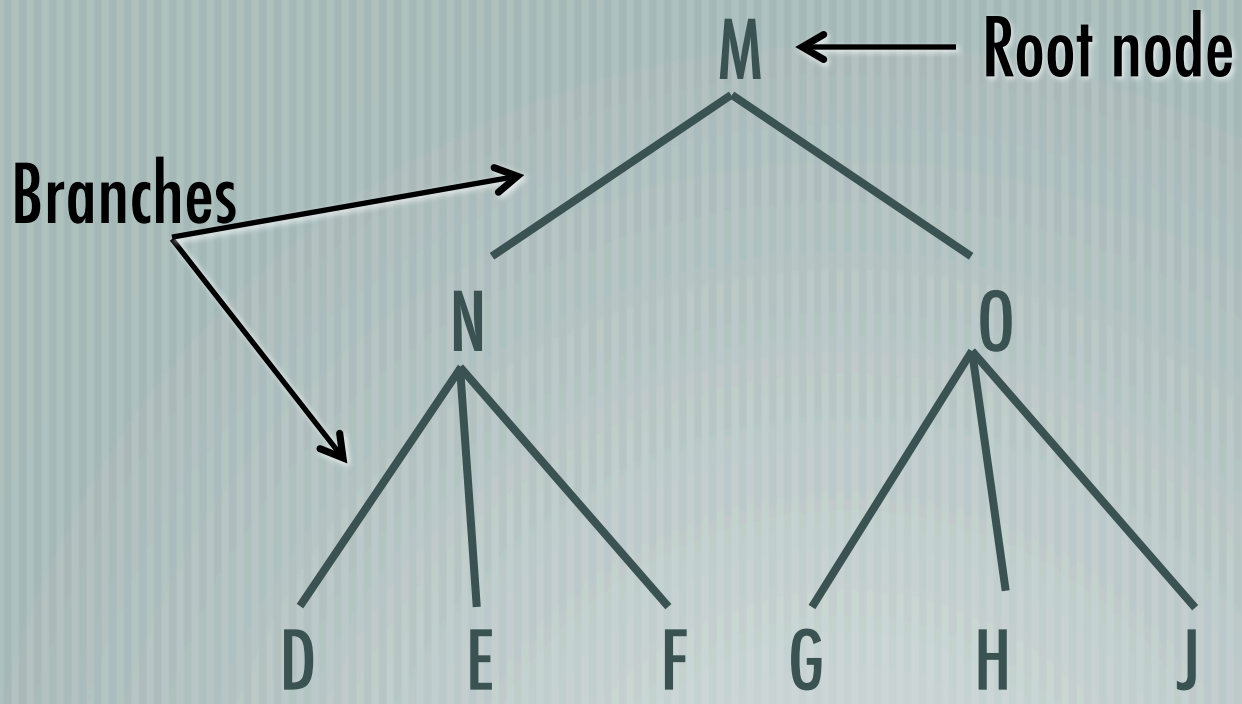

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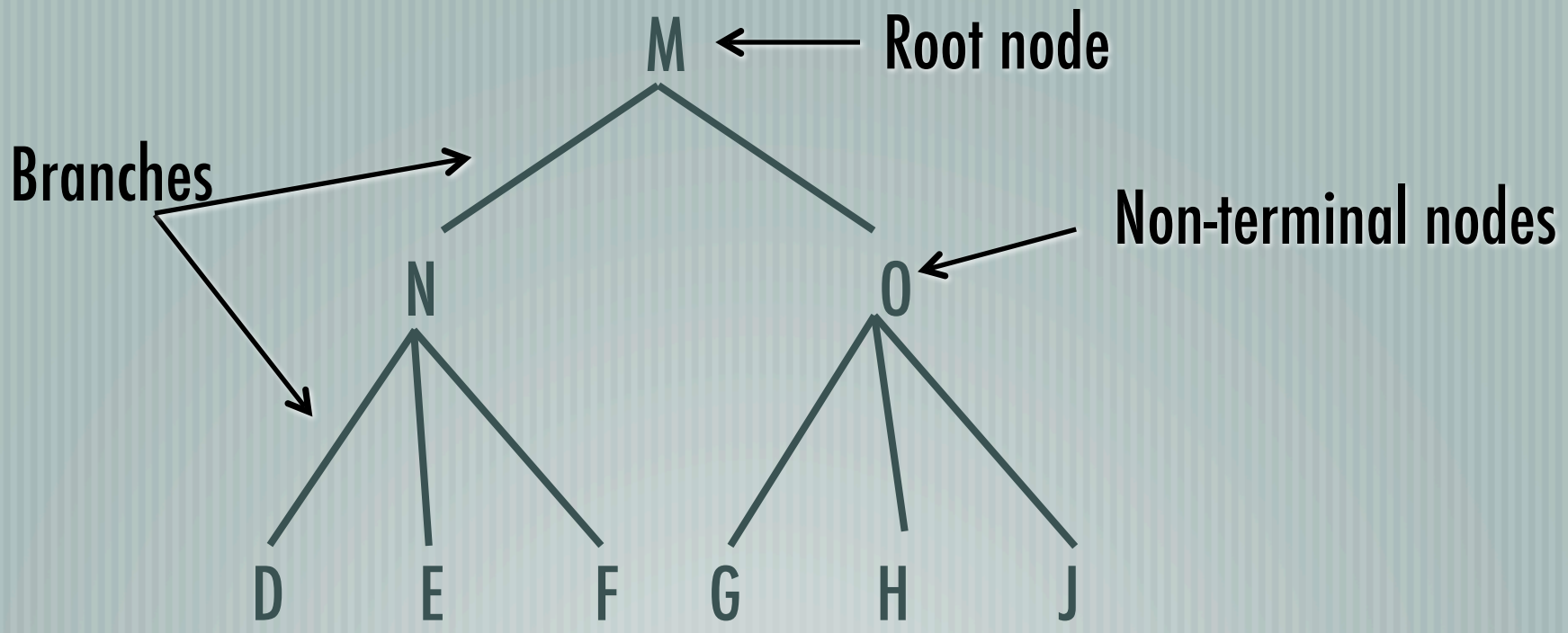

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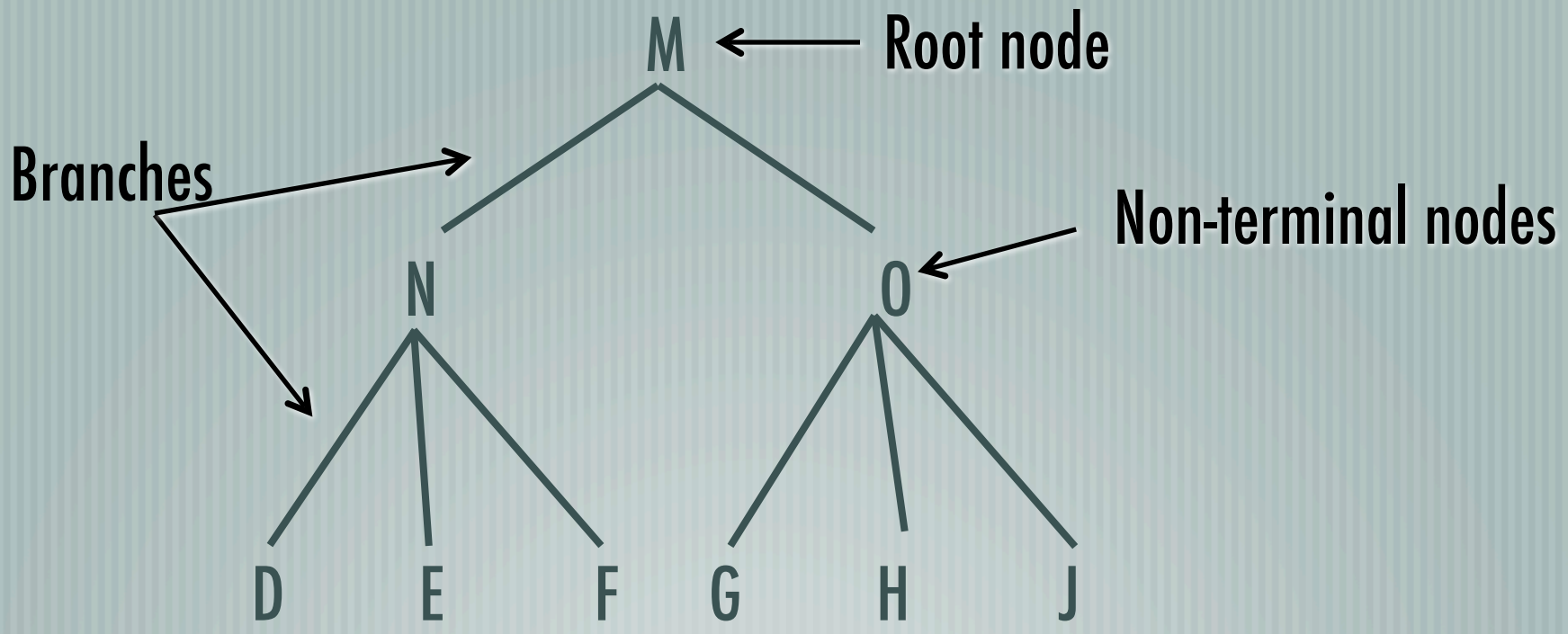

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Domination

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Domination

- Intuitively: this is **containment.** If a node contains another, then it dominates it:

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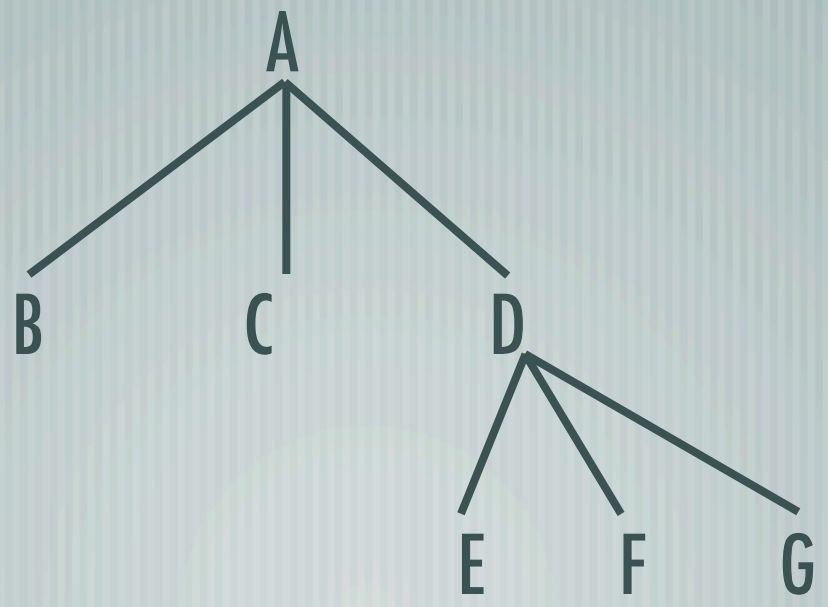

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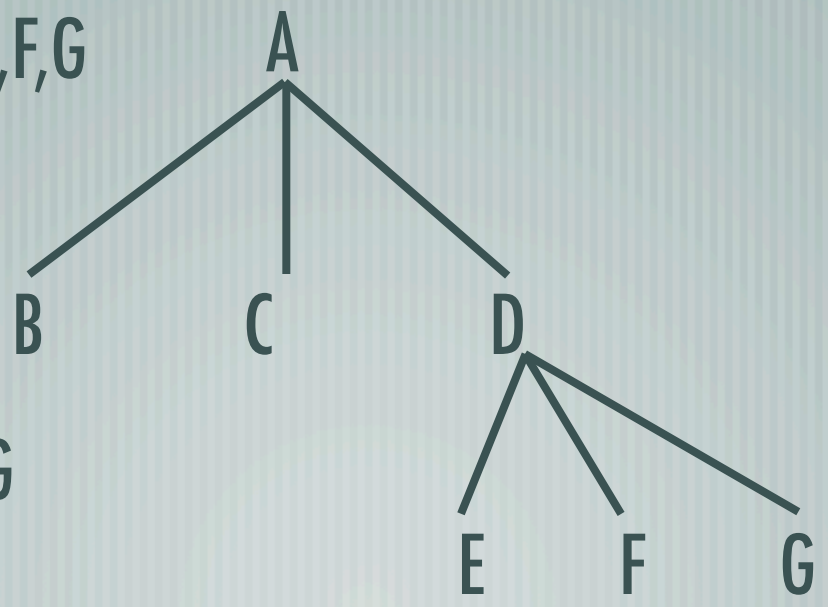
Domination

- Intuitively: this is **containment.** If a node contains another, then it dominates it:

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

D dominates E,F,G



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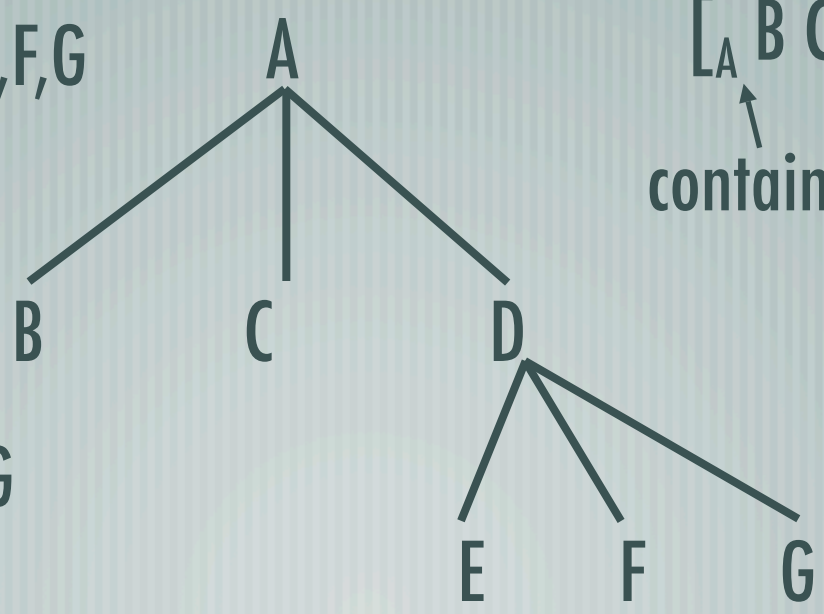

$[_A$ B C $[_D$ E F G$]]$

contained inside $[_A\ ]$

D dominates E,F,G

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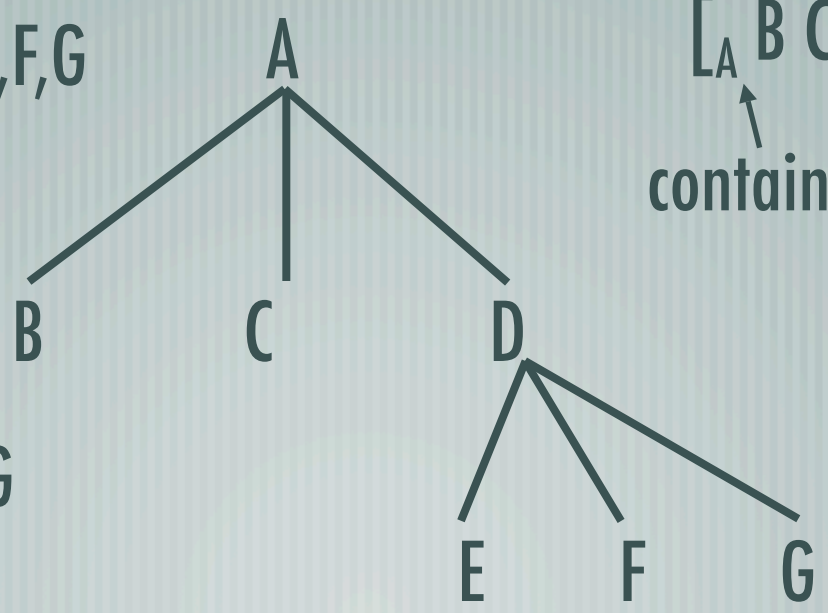
A dominates B,C,D,E,F,G



$[_A$ B C $[_D$ E F G]]

contained inside $[_A$]

D dominates E,F,G

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

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Domination

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Domination

- 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.

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Immediate Domination

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Immediate Domination

- 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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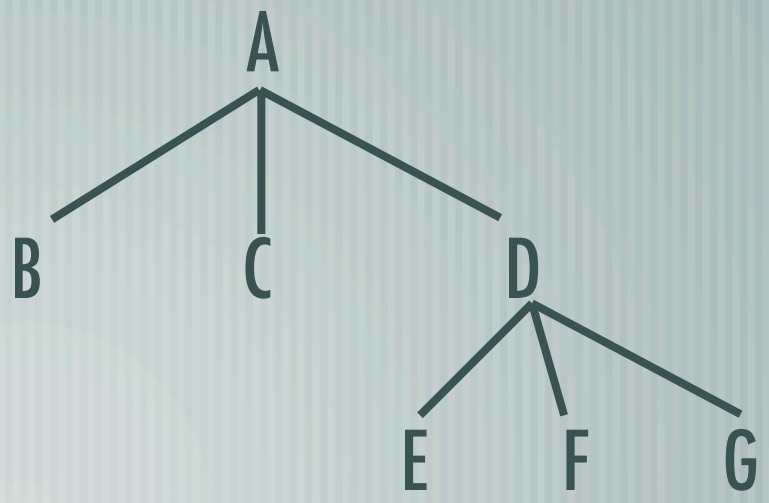

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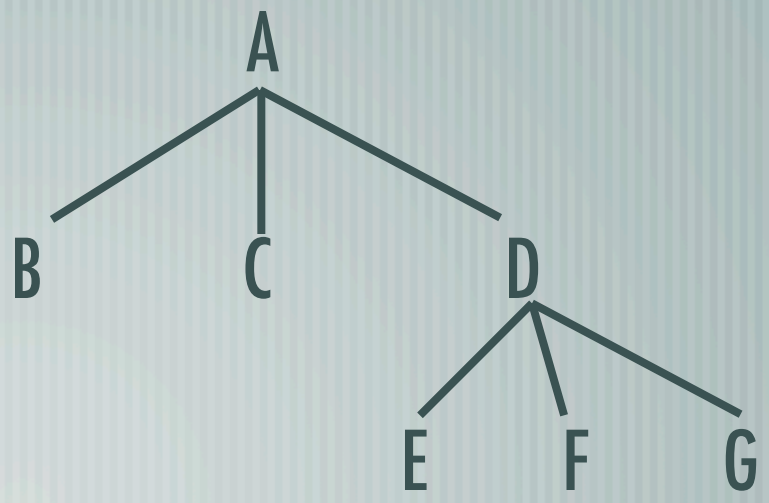

A dominates B,C,D,E,F,G

but A immediately dominates only B,C,D

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Exhaustive Domination

- Node A exhaustively dominates a **SET** of **TERMINAL** nodes {B,C,...,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.

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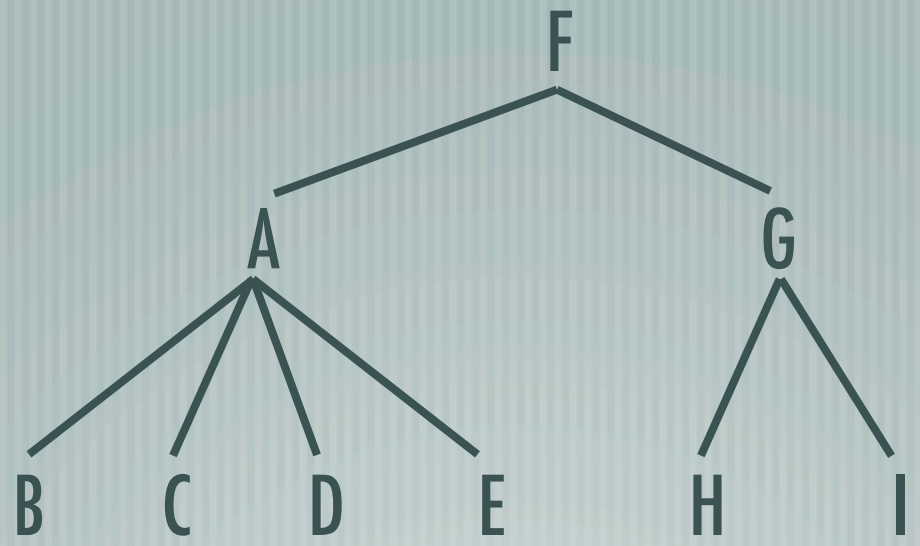
Exhaustive Domination



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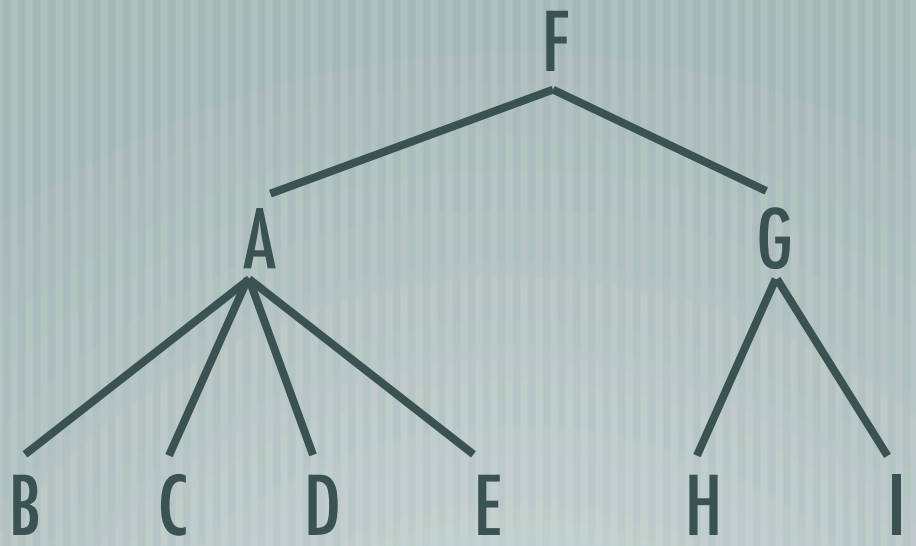

A exhaustively dominates the set {B,C,D,E}

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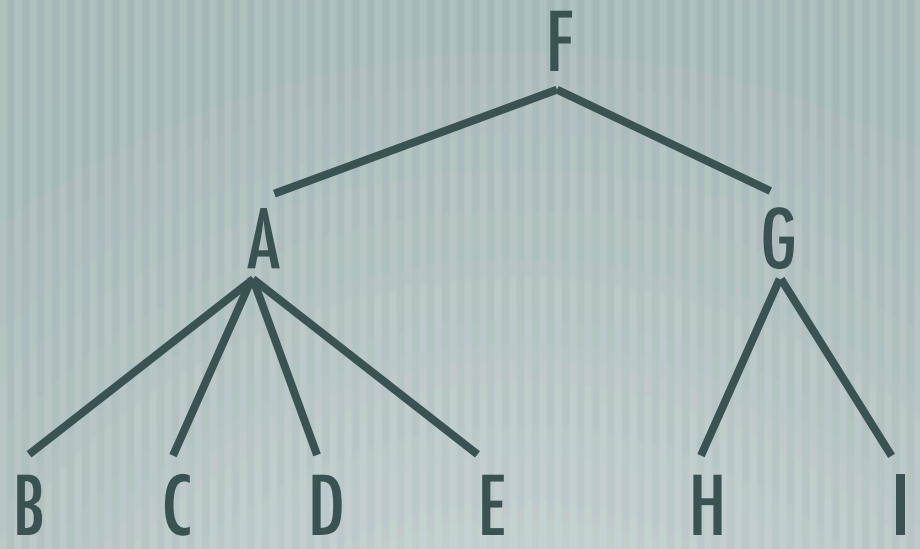
Exhaustive Domination



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

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

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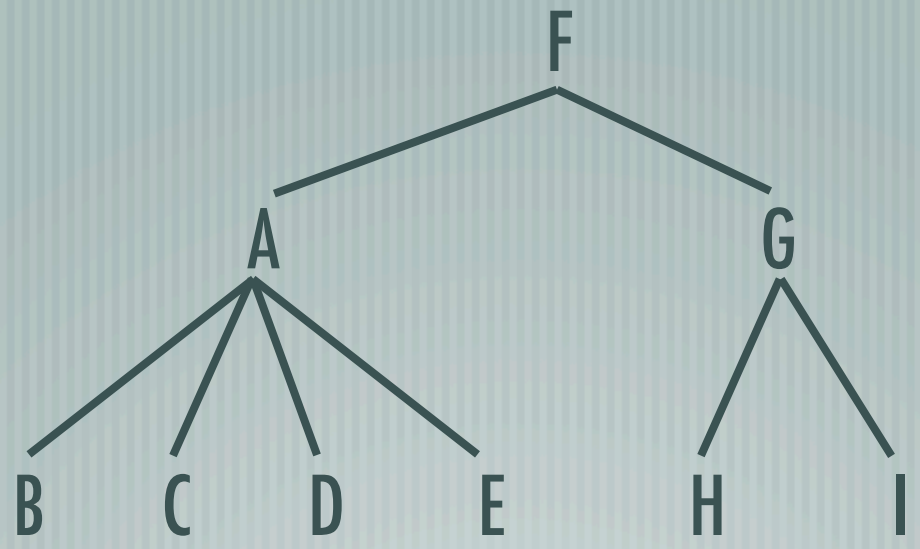
Exhaustive Domination



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

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

A does **NOT** exhaustively dominate the set {B,C,D,E,H}

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A formal definition of constituency

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A formal definition of constituency

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

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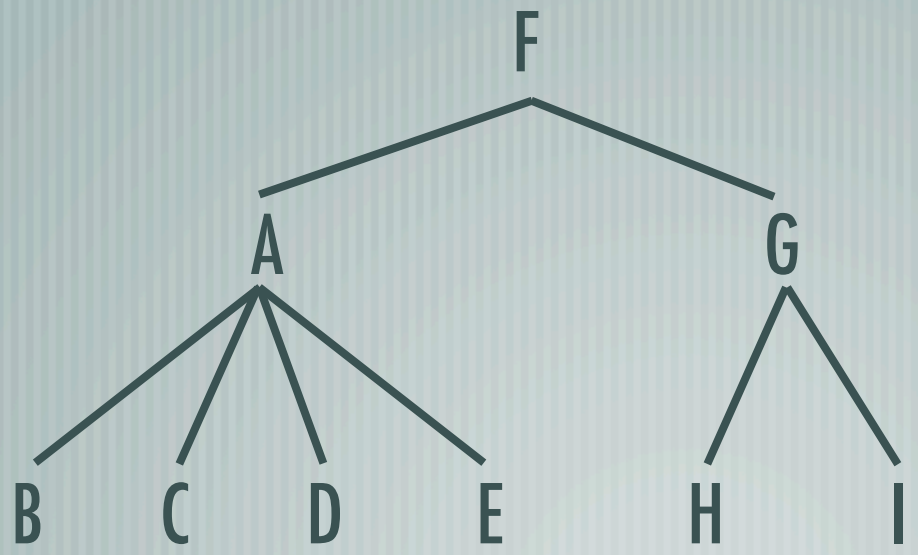
A formal definition of constituency

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



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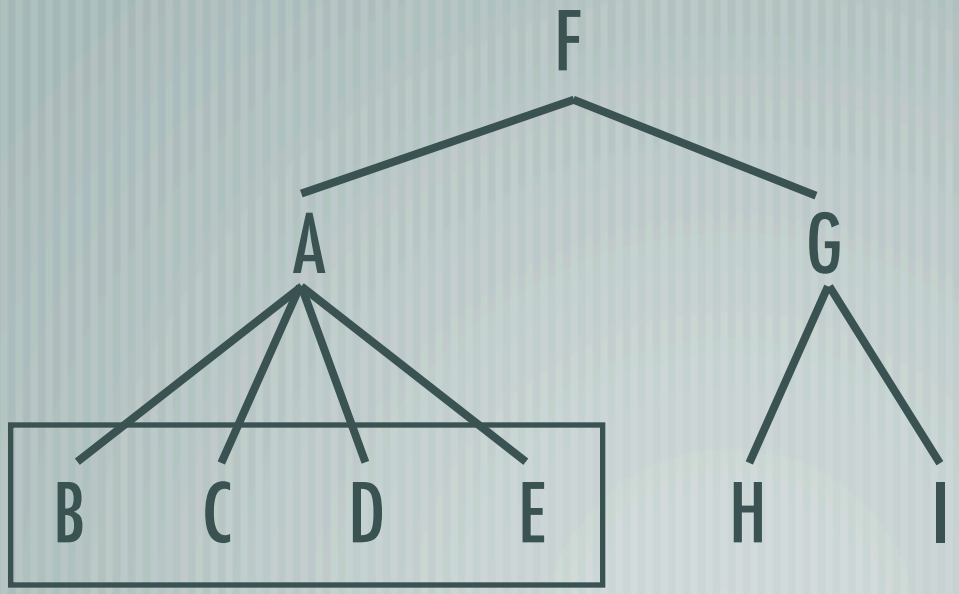

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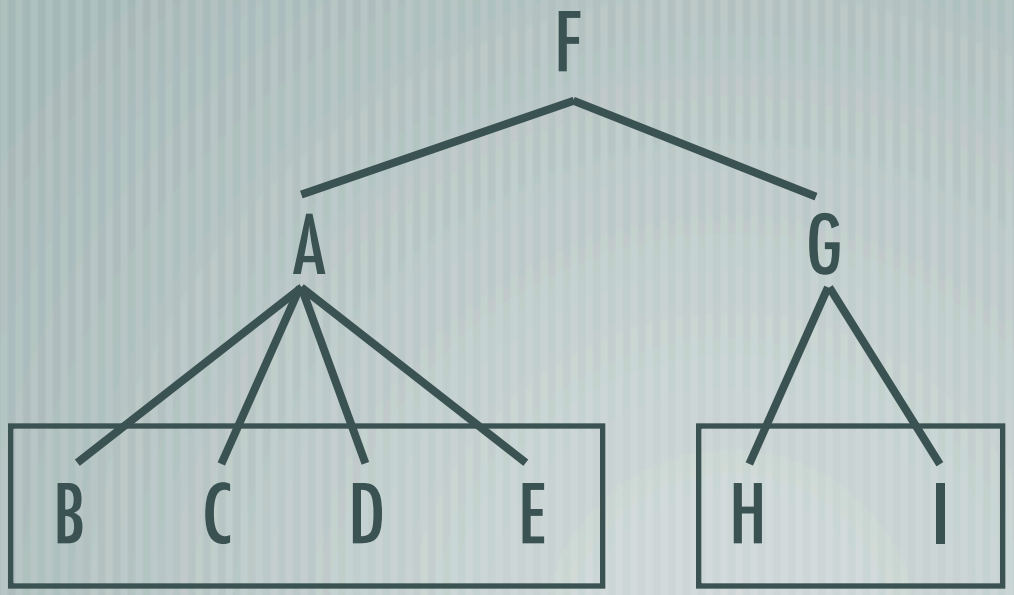

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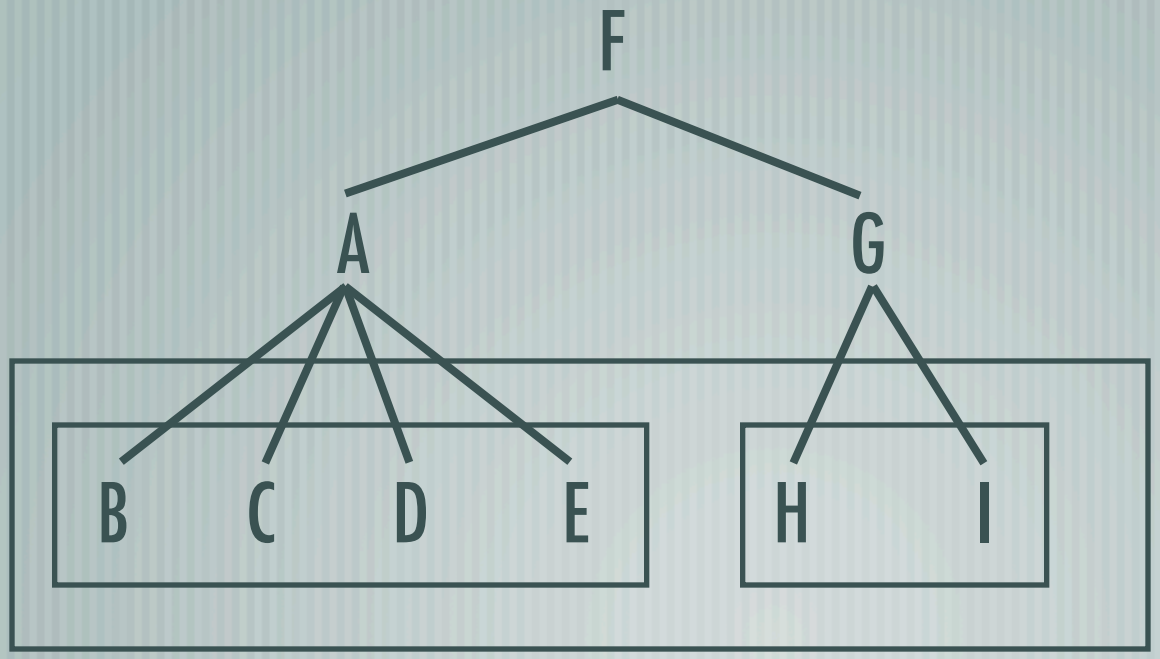

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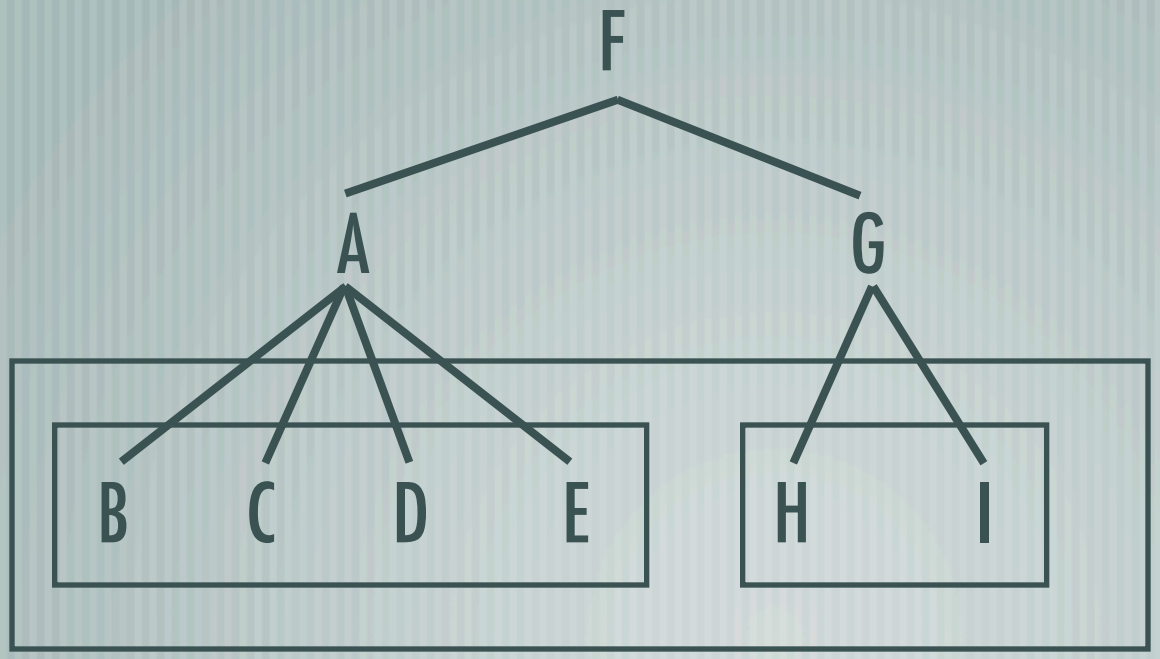

{E, H} are NOT a constituent

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Constituent vs Constituent of

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Constituent vs Constituent of

- Constituent of does NOT mean the same thing as constituent.

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- **Constituent of** does NOT mean the same thing as constituent.
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- A dominates B, then we say B is a constituent of A.

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Constituent vs Constituent of

- **Constituent of** does NOT mean the same thing as constituent.
- Essentially 'constituent of' is the **opposite of domination.**
- A dominates B, then we say B is a constituent of A.
- **immediate constituent of** is the opposite of immediate domination.

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Some Informal Terms

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Some Informal Terms

- **Mother**: the node that immediately dominates another.

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Some Informal Terms

- **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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Some Informal Terms

- **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.

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Root and Terminal Nodes

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Root and Terminal Nodes

- **Root node**: A node with no mother

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Root and Terminal Nodes

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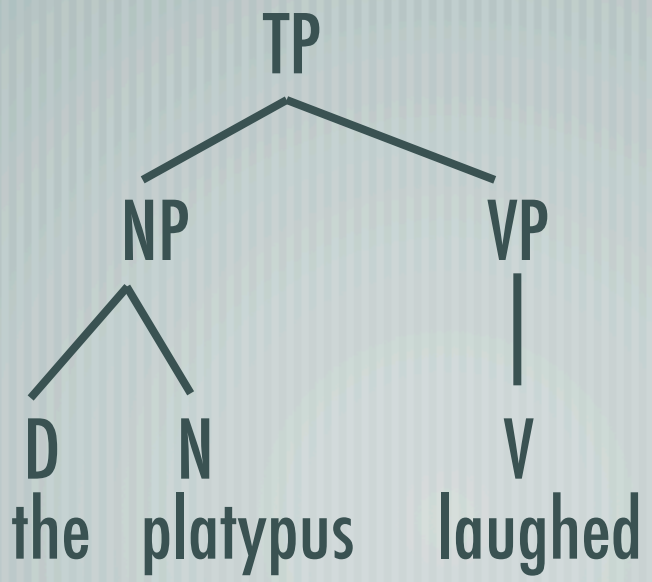

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Root and Terminal Nodes

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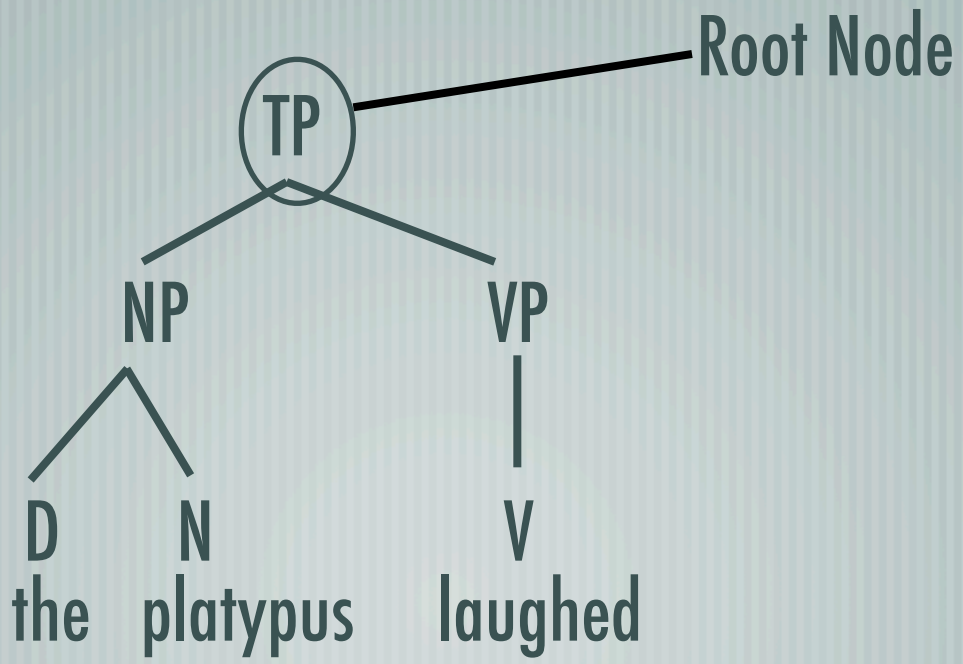

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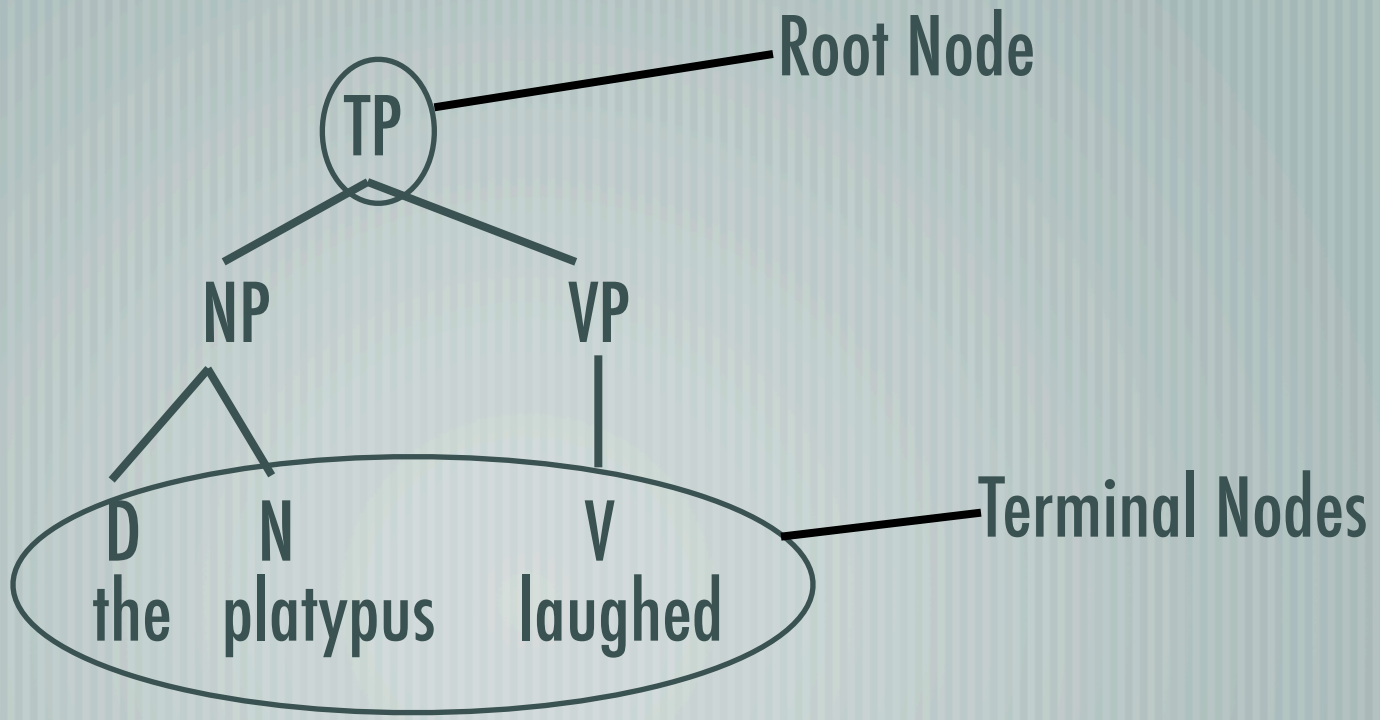

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Precedence

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Precedence

- **Precedence**: Node A precedes node B if A is to the left of B. (informal definition)

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Precedence

- **Precedence**: Node A precedes node B if A is to the left of B. (informal definition)
- But this runs into problems with trees which are badly drawn

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Precedence excludes domination

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Precedence excludes domination

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

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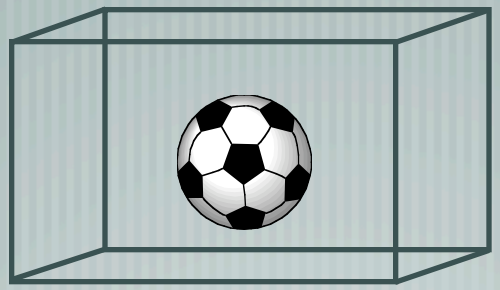

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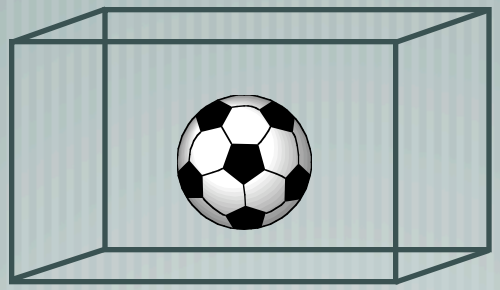

Is the ball to the left or right of the box?

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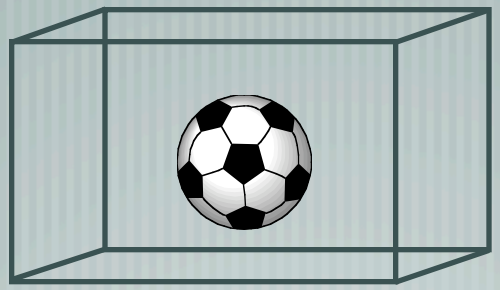

Is the ball to the left or right of the box?

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

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Precedence

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Precedence

- Consider this poorly drawn tree

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Precedence

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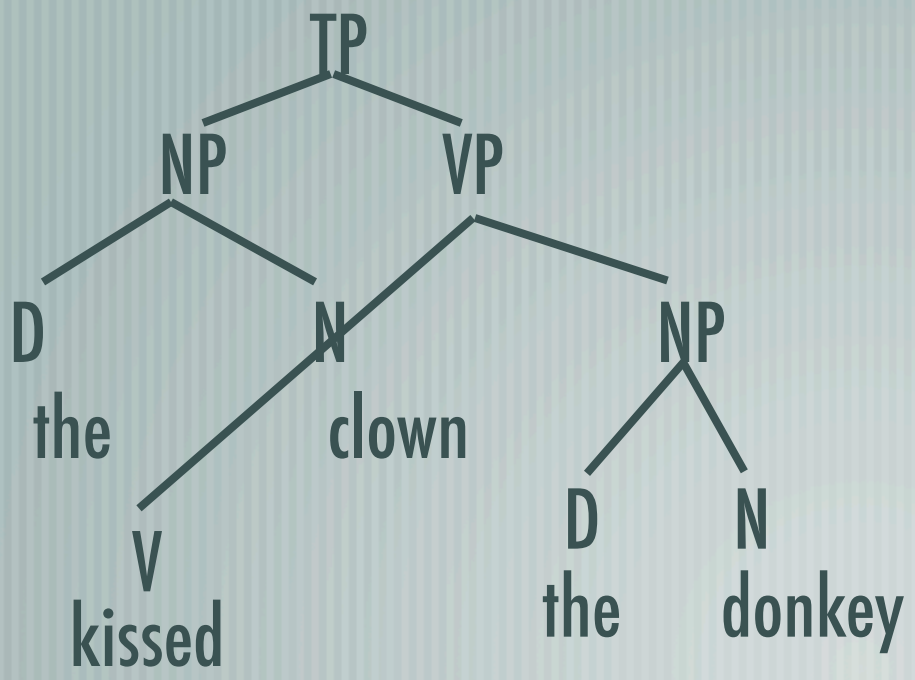

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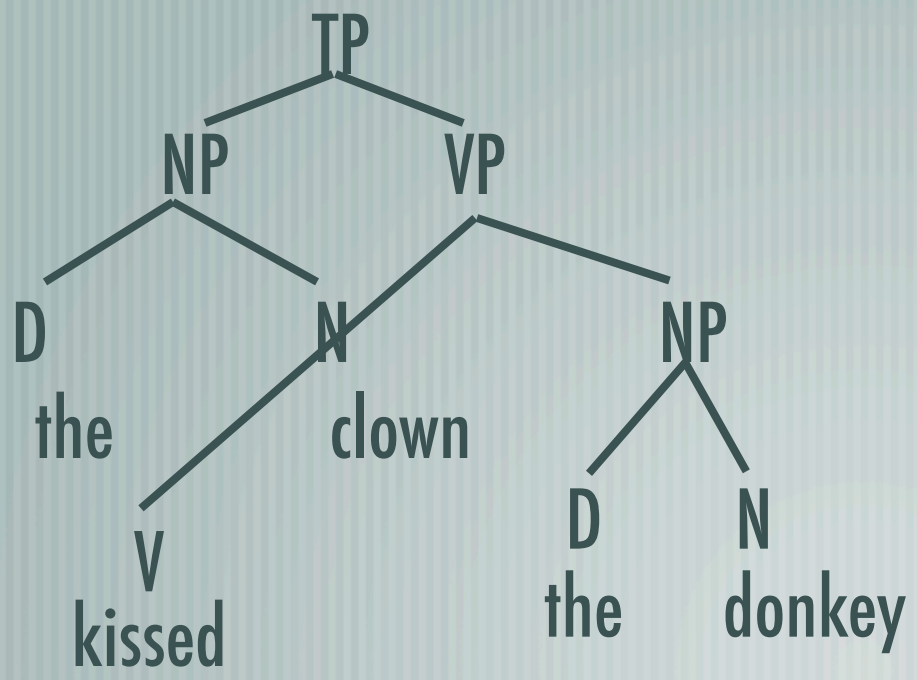

Does kiss precede clown?
Obviously not!

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Precedence

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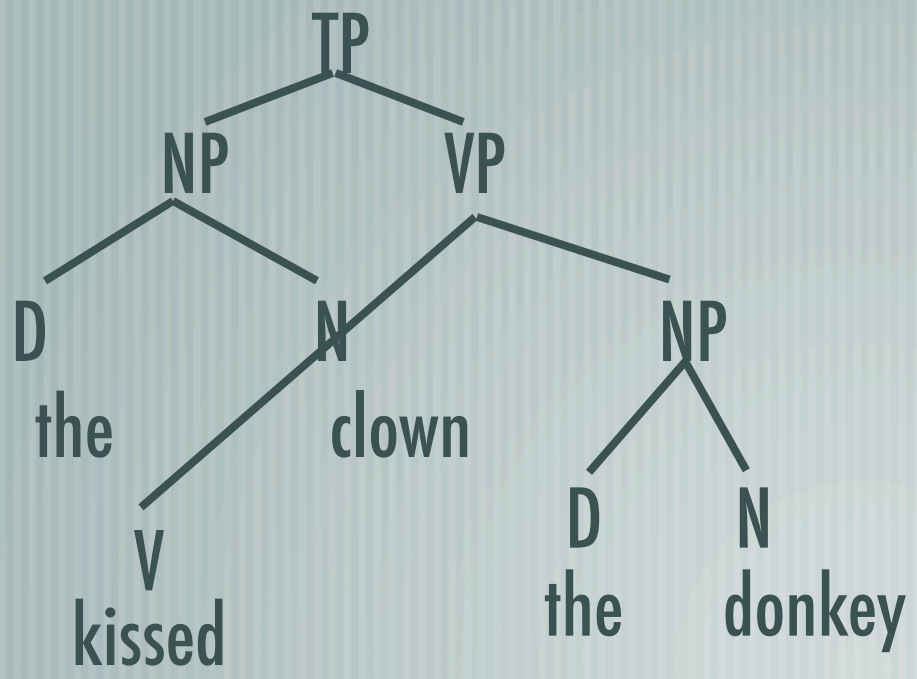

Does kiss precede clown?
Obviously not!

What is crucial here is that the dominator of clown precedes the dominator of kissed

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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

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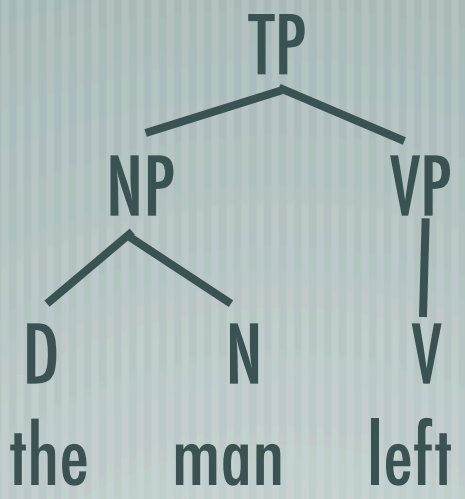
Sister-Precedence



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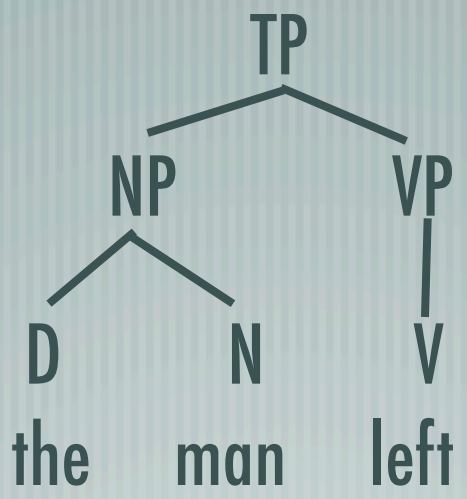

NP sister-precedes VP

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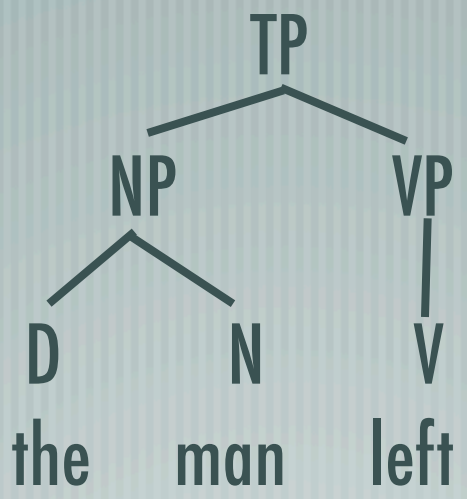
Sister-Precedence



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D sister precedes N

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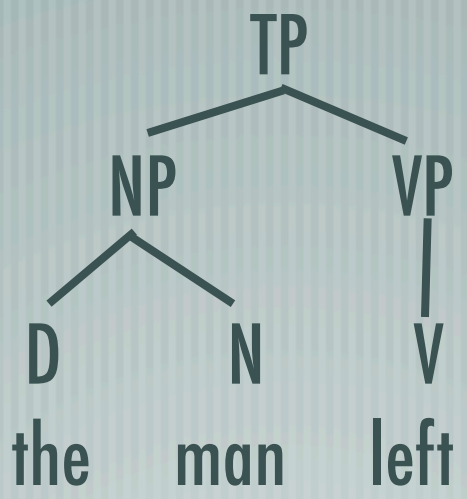
Sister-Precedence



NP sister-precedes VP

D sister precedes N

N does NOT sister precede V (nor does D)

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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.

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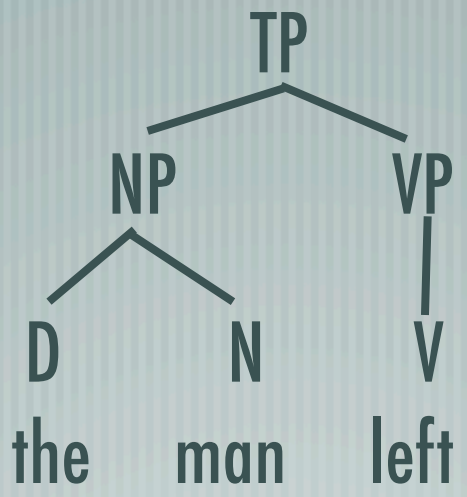
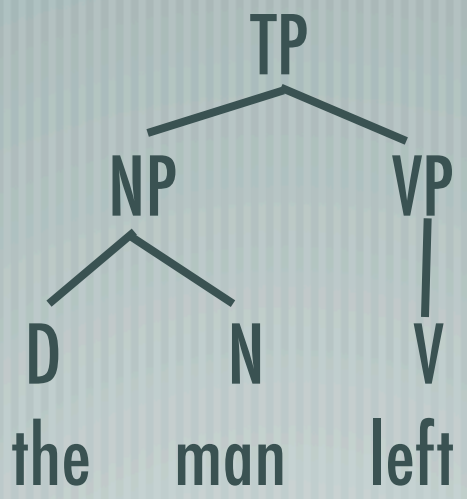
Sister-Precedence ≠ Immediate Precedence



But N does immediately precede V

Sister-Precedence ≠ Immediate Precedence

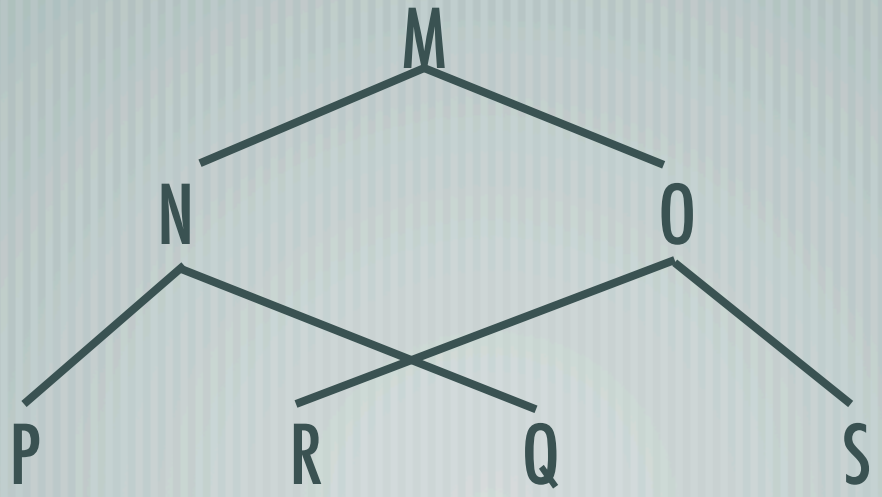


N does NOT sister-precede V

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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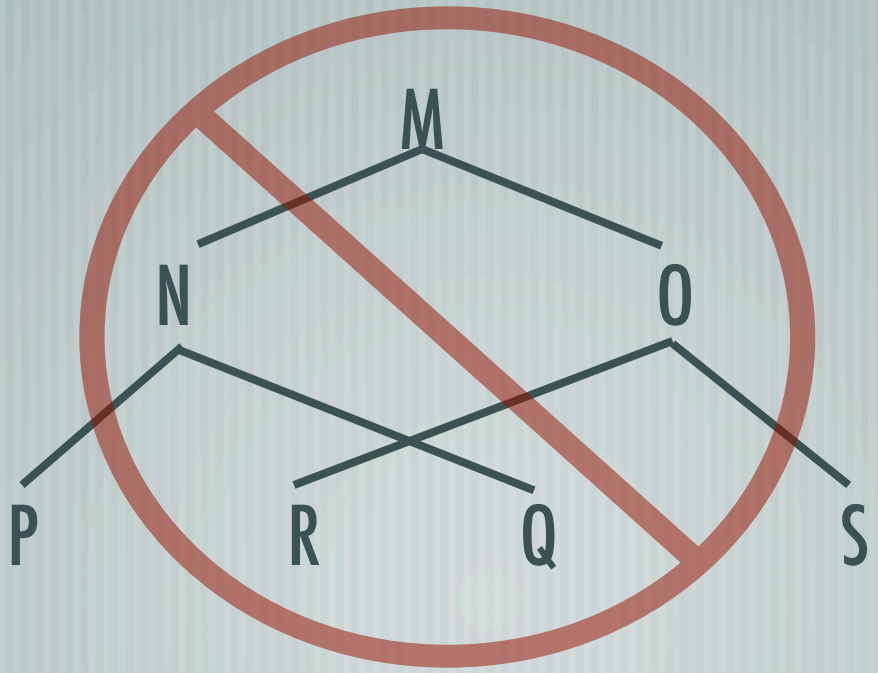

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A B G

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A G B

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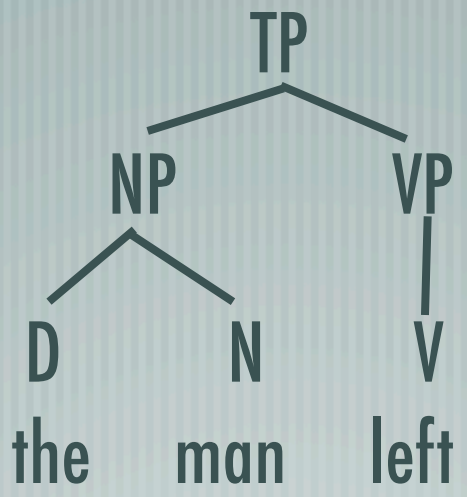
Sister-Precedence ≠ Immediate Precedence



But N does immediately precede V

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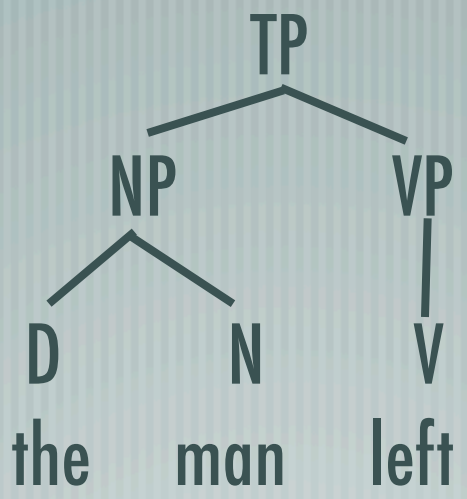
Sister-Precedence ≠ Immediate Precedence



N does NOT sister-precede V

But N does immediately precede V

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C-command

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C-command

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

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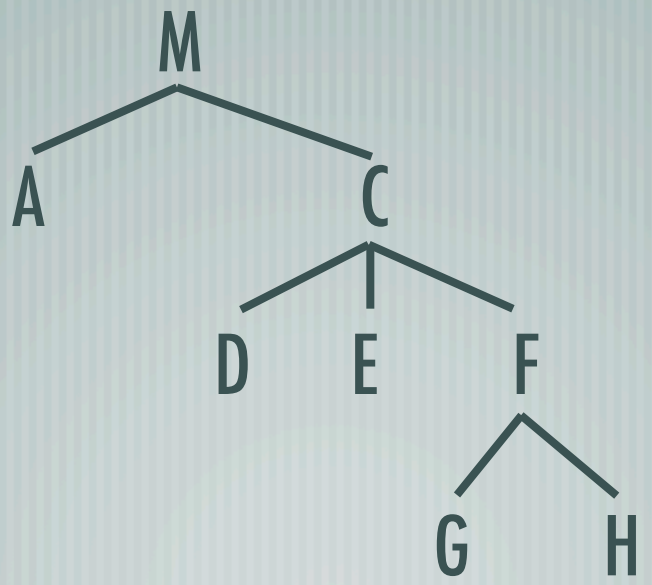
C-command

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



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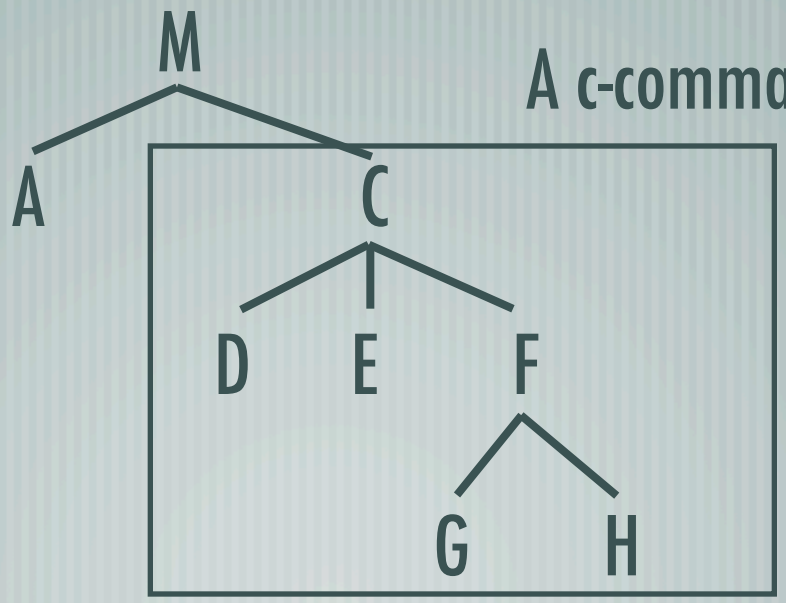
C-command

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



A c-commands C,D,E,F,G,H

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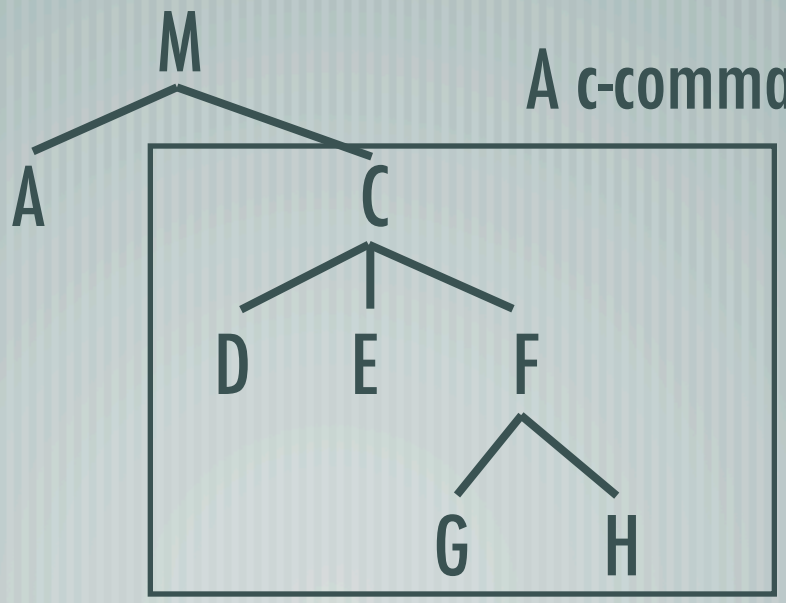
C-command

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



A c-commands C,D,E,F,G,H

Note: D does NOT c-command A

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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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C-command

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

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C-command

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

Sisterhood

you can't command something you dominate

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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

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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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Symmetric C-command

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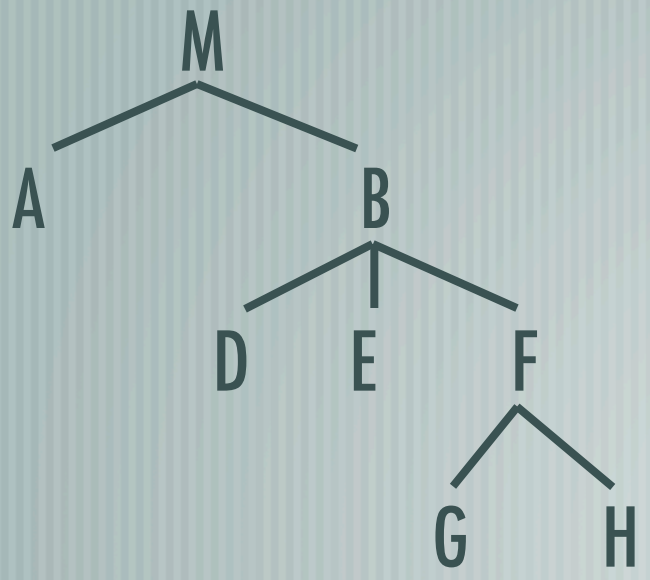

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Symmetric C-command

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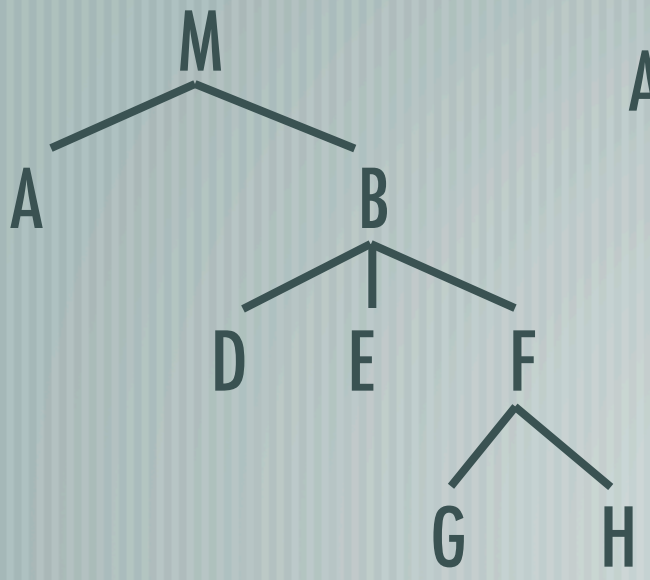

A & B symmetrically c-command one another

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Symmetric C-command

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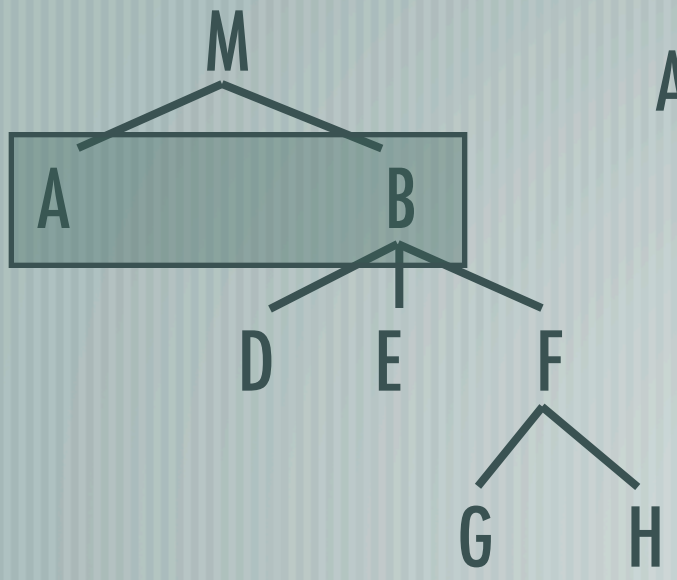

A & B symmetrically c-command one another

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Symmetric C-command

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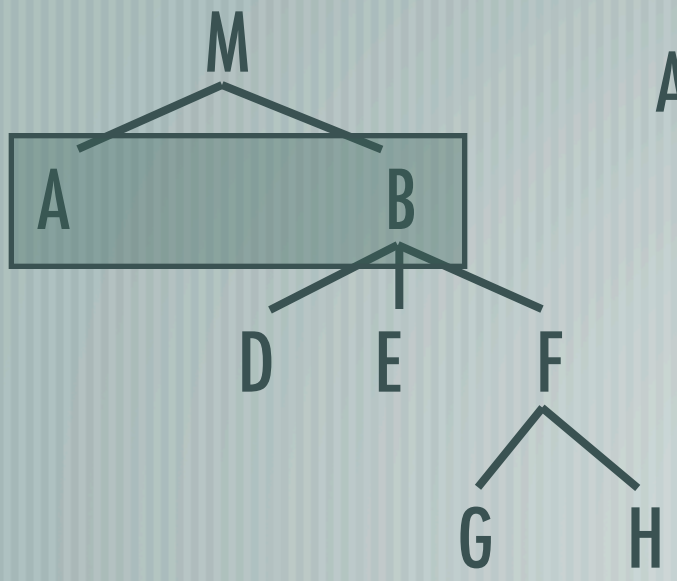

A & B symmetrically c-command one another

A does NOT symmetrically c-command D

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Asymmetric C-command

- 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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Asymmetric C-command

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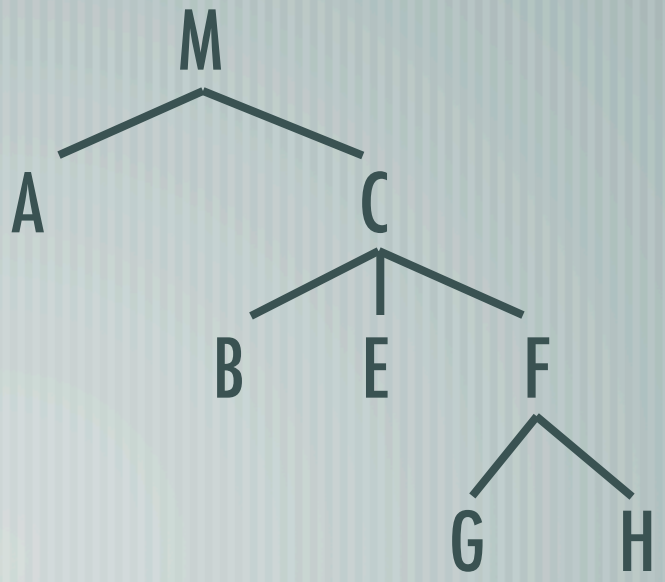

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Asymmetric C-command

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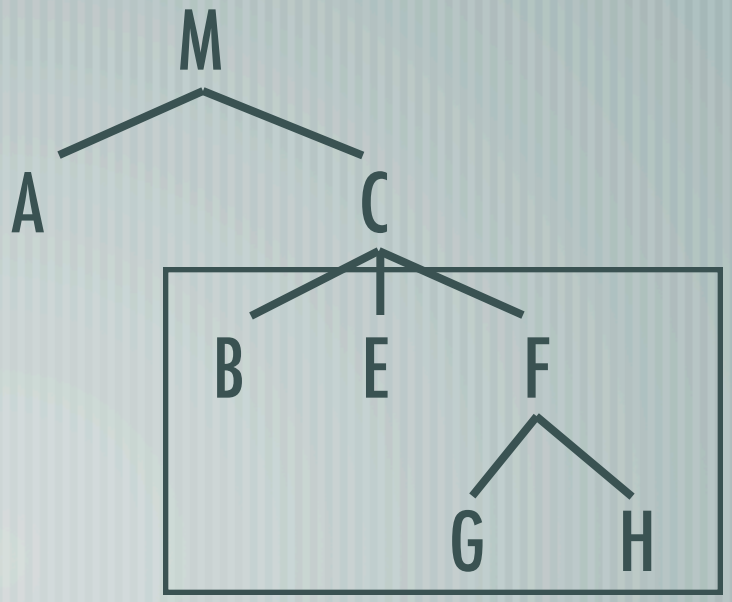

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Grammatical Relations

- **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)

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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.

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Grammatical Relations

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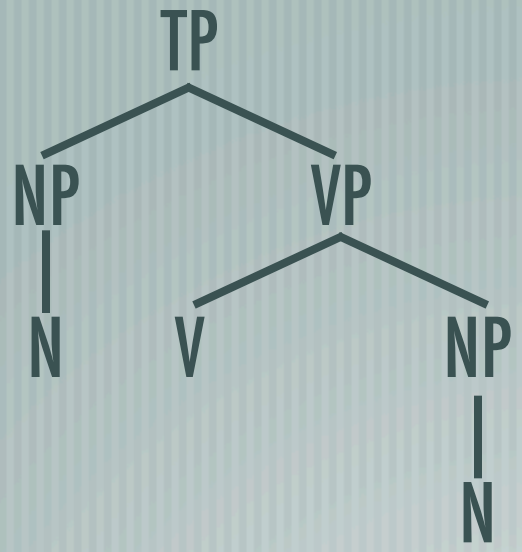

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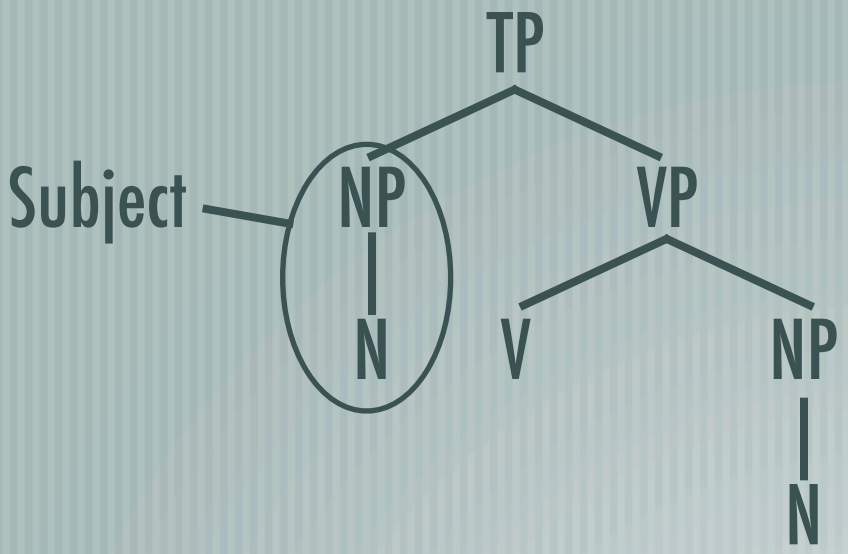
Grammatical Relations



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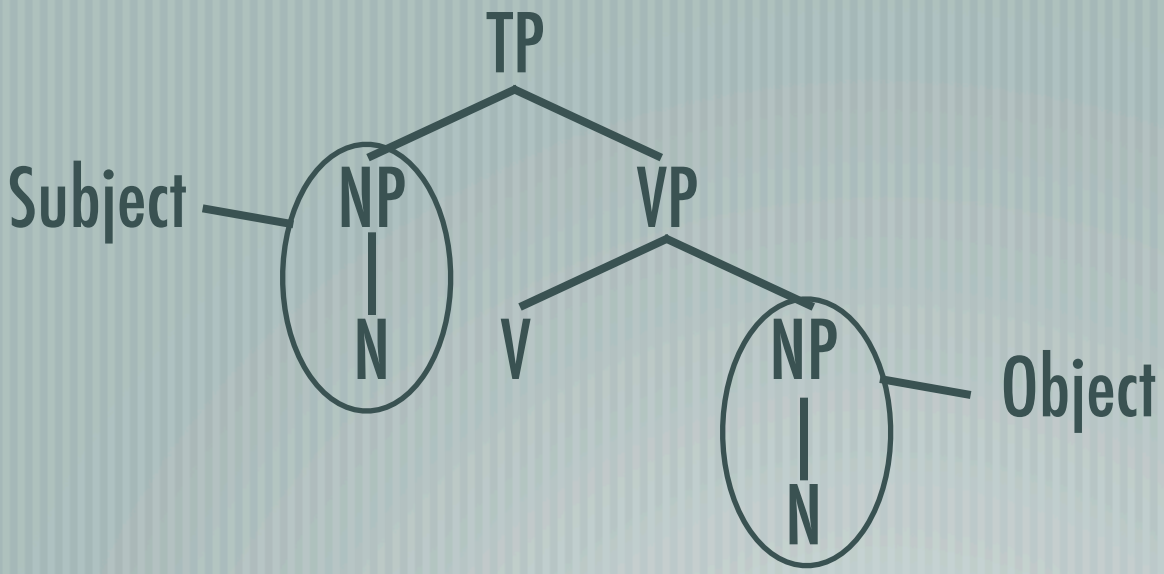

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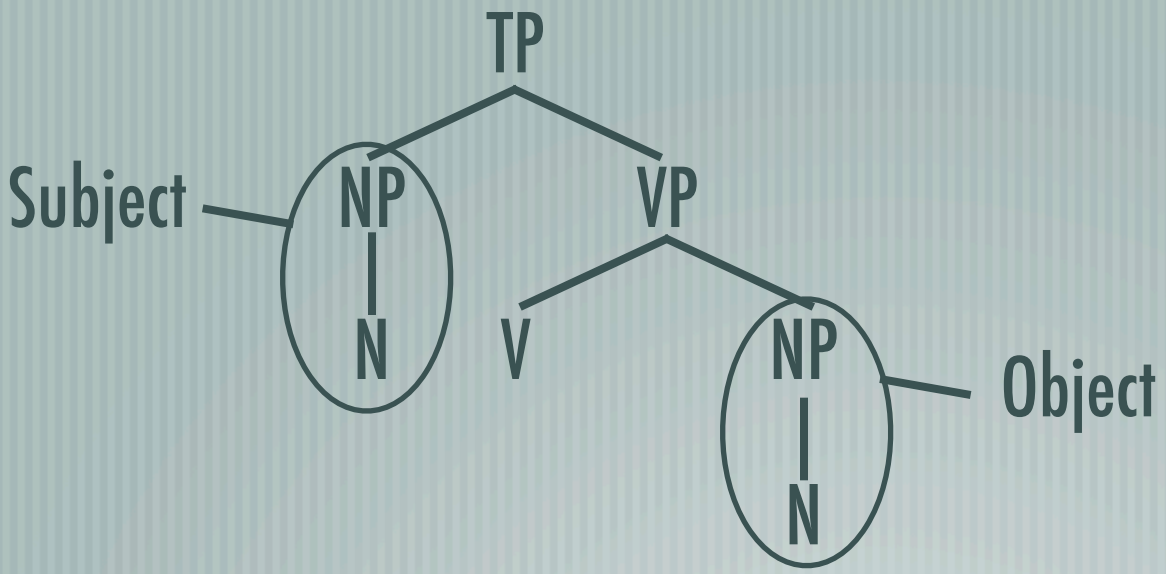

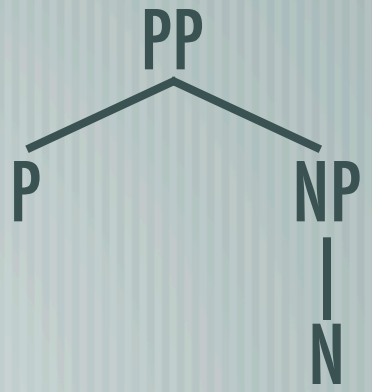

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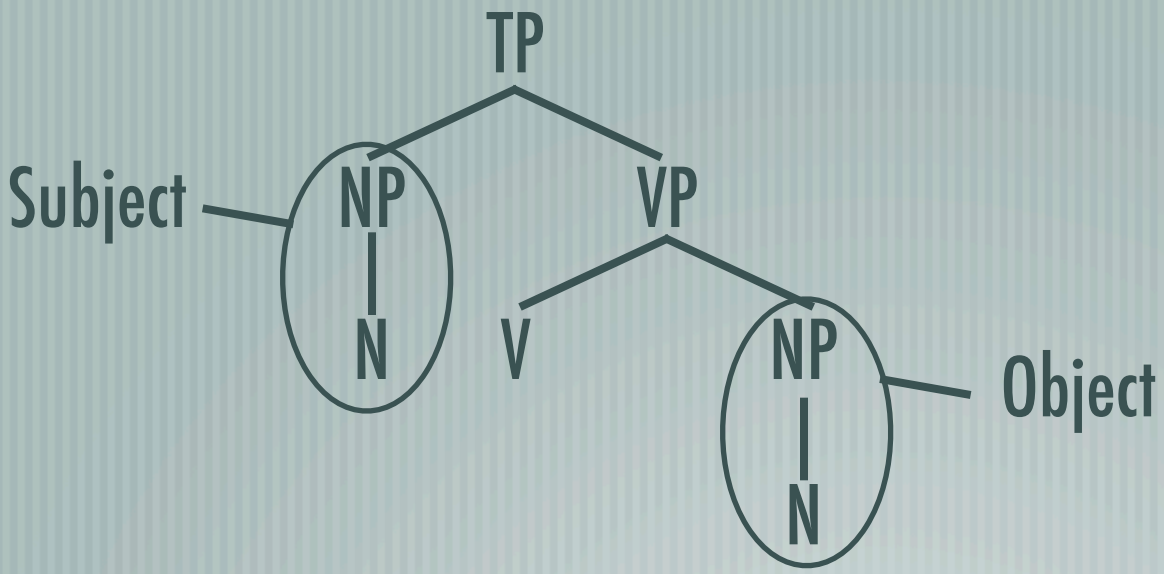

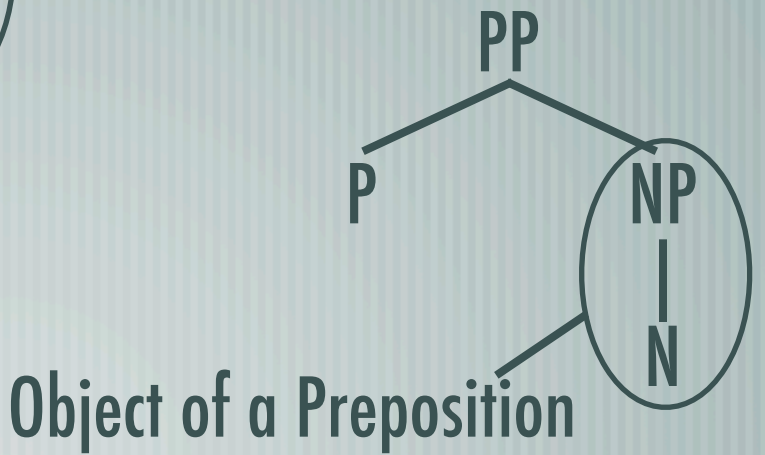

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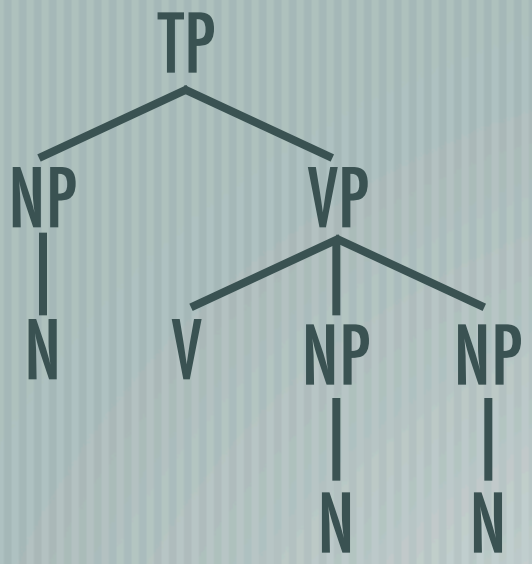

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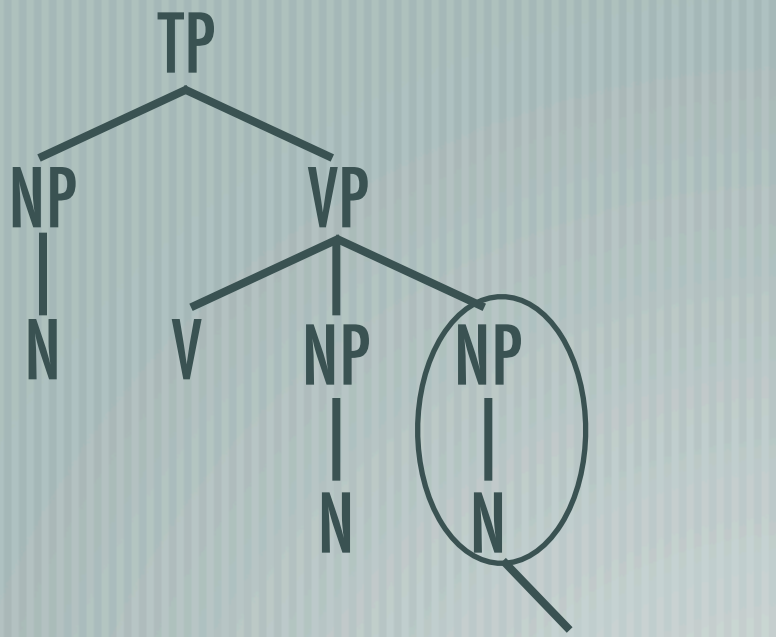

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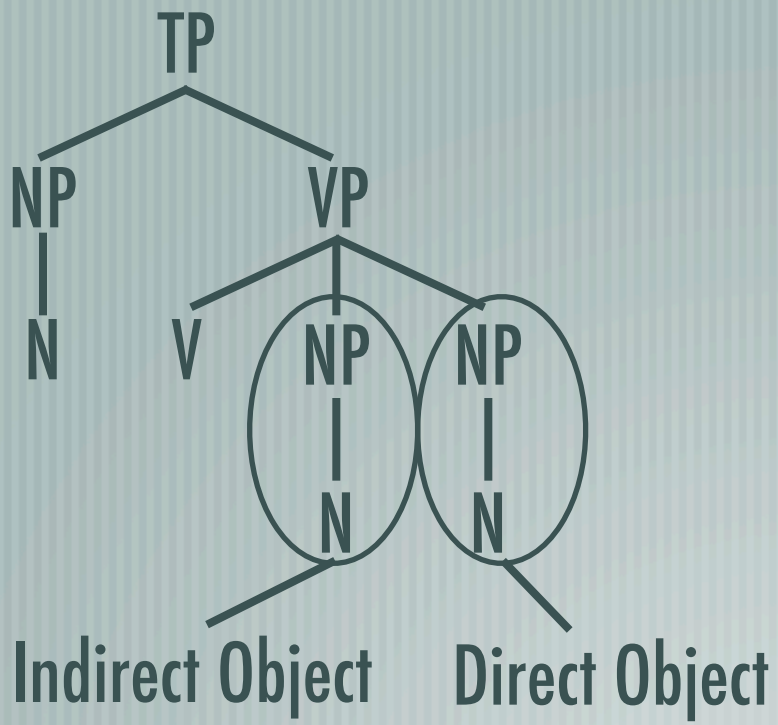

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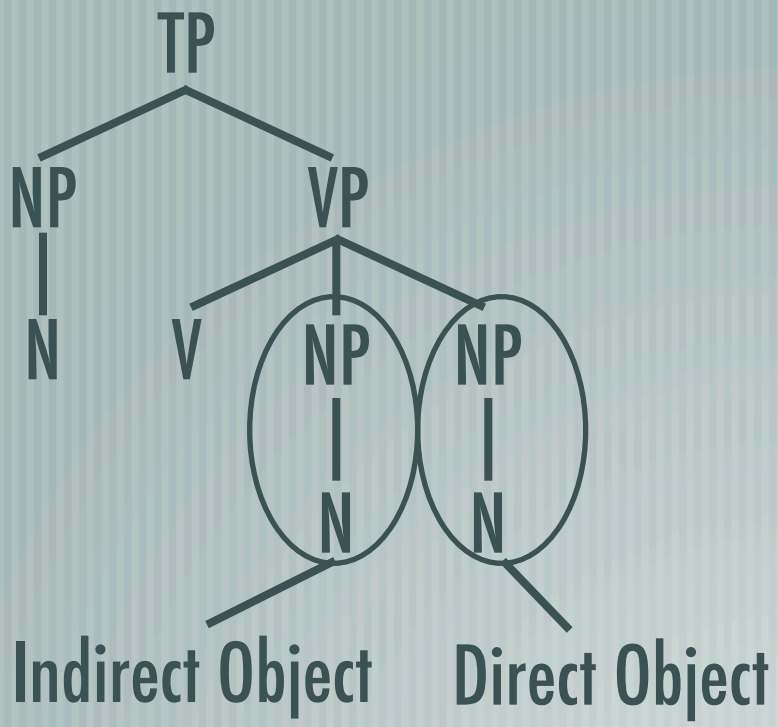

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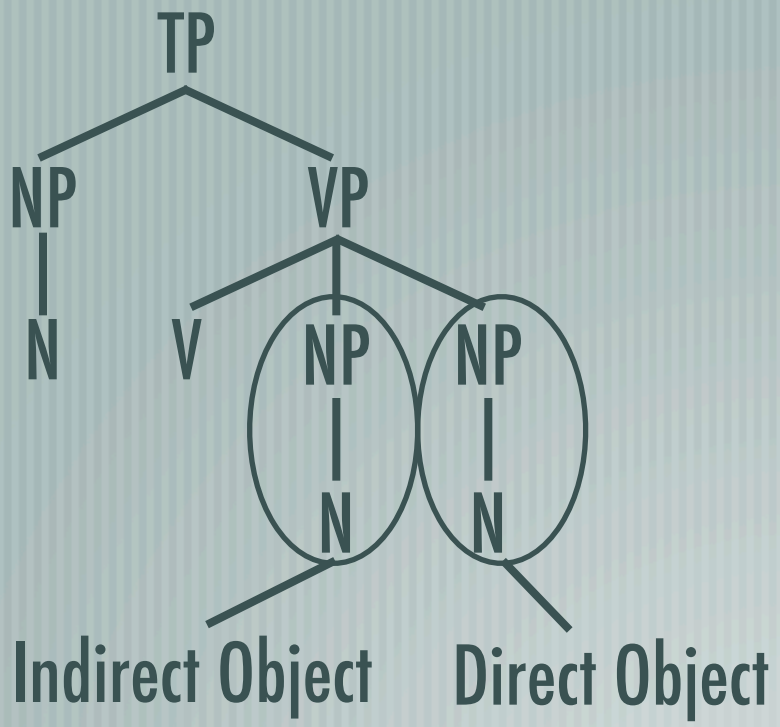

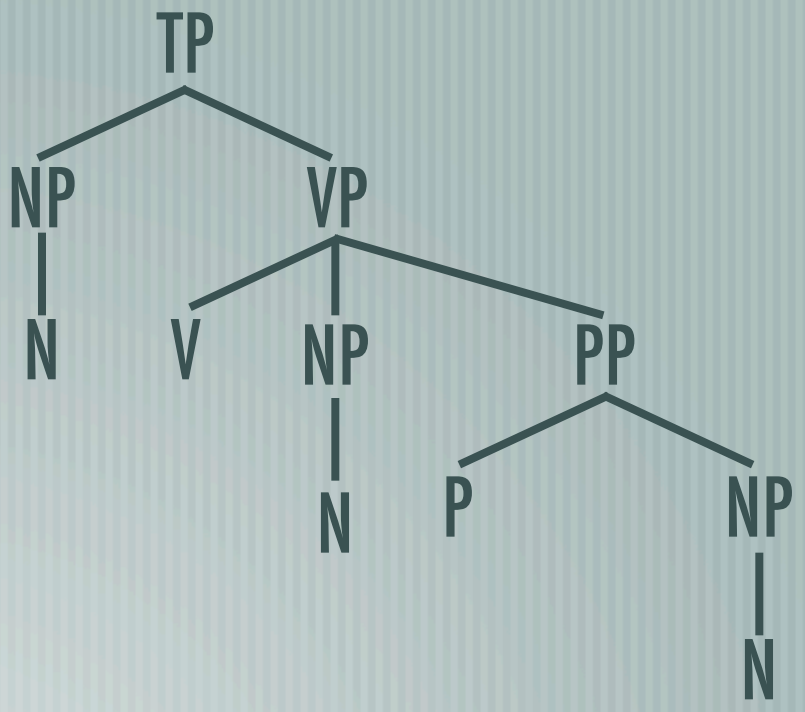

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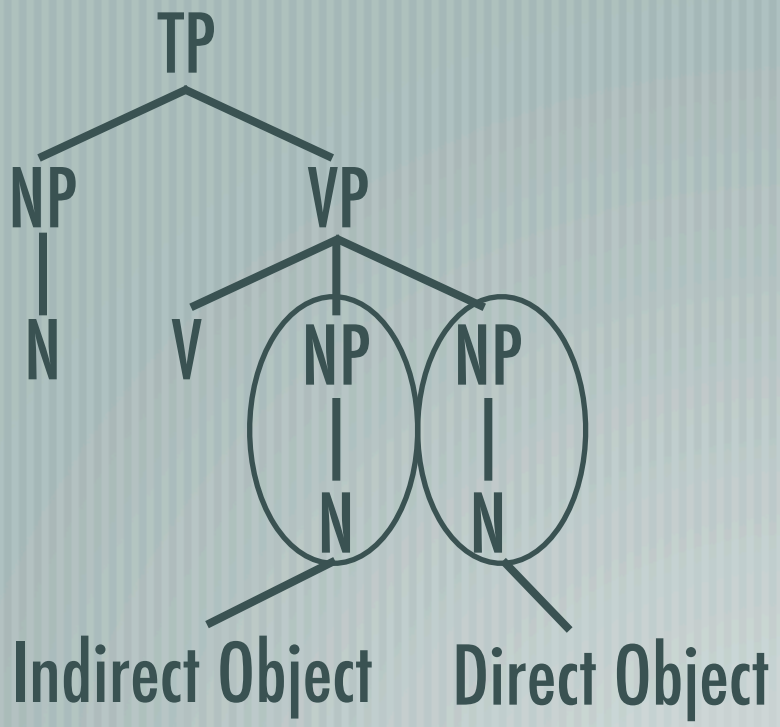

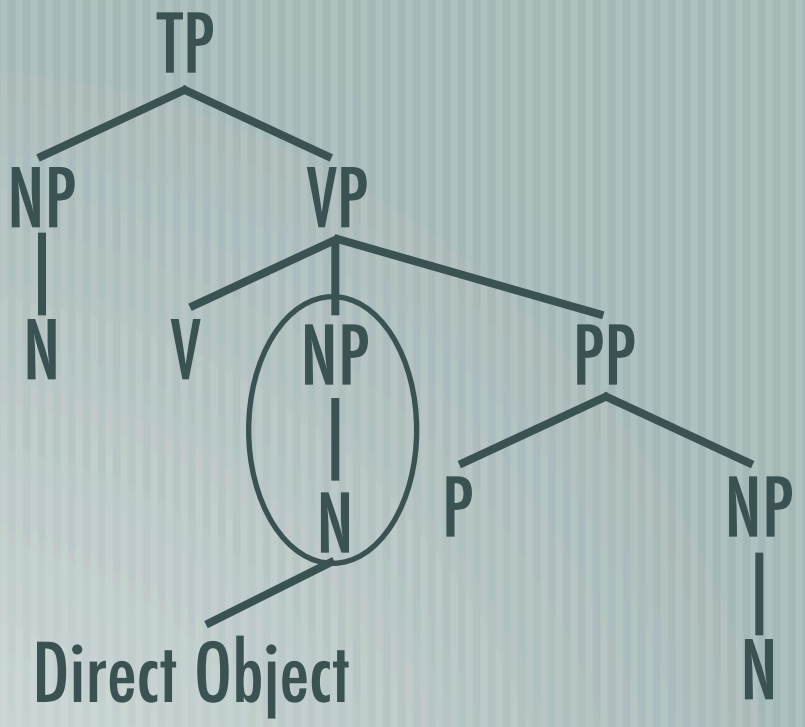

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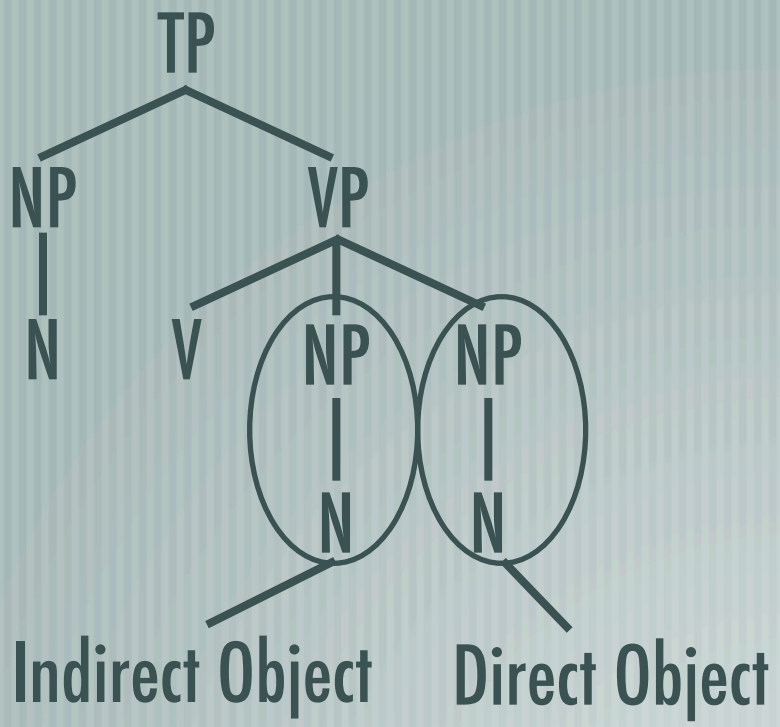

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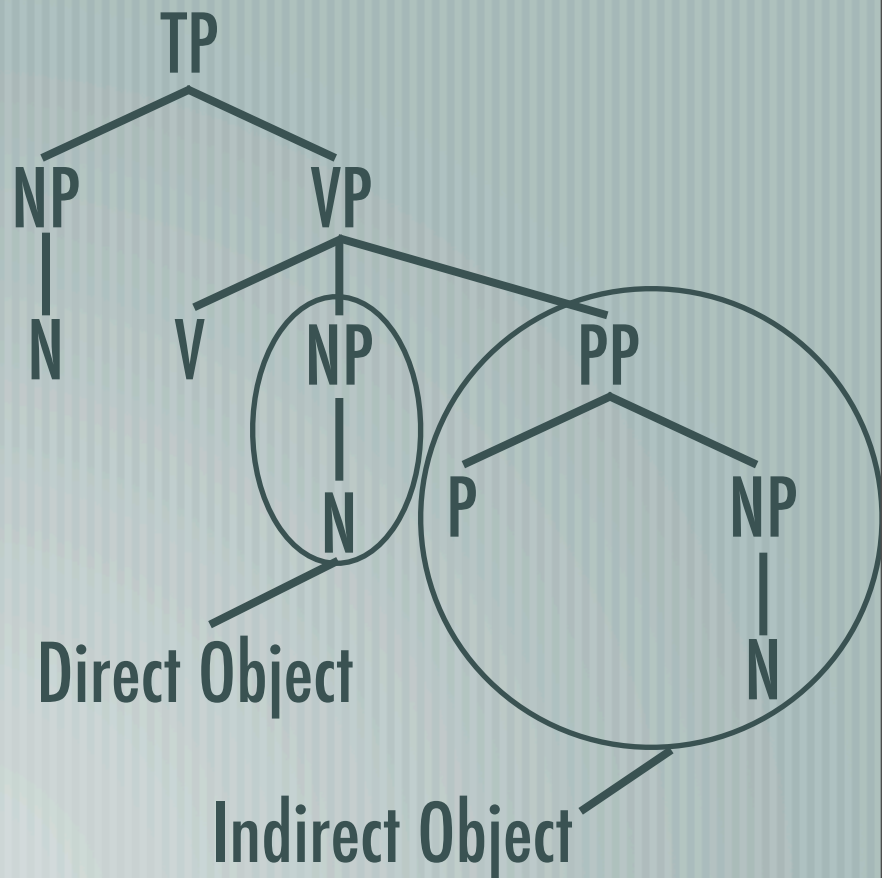

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Summary

- **Structural Relations**: relationships between nodes.
- **Dominance** (=containment)
  - immediate dominance (=motherhood)
  - exhaustive dominance (=constituent)
- **Precedence** (≃to the left)
  - immediate precedence (=adjacent & to the left)

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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.

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