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 relationships are actually very simple! Don’t let the formalism scare you!**

In mathematics, a **GRAPH** is an abstract representation of a set of objects where some pairs of the objects are connected by links.

A sequence of connected edges is called a **PATH**.

**Trees** – like the kind we see in syntax – are just a special kind of graph.
A **TREE** is an undirected graph in which any two nodes are connected by exactly one path.

Not a tree!

Not a tree!

Not a tree!

Not a tree!

Not a tree! (because there are two trees)

The edges in trees are called **BRANCHES**.

A node’s branches are the nodes that come under the node.

E.g., the node **H** has 3 branches. The node **E** has 2. Nodes **I** and **J** don’t have any.
A node \( x \) DOMINATES a node \( y \) if and only if there is a downward path from \( x \) to \( y \).

In other words: \( x \) dominates \( y \) in a tree if you can trace a path from \( x \) to \( y \) without going up in the tree.

Or: \( x \) dominates \( y \) whenever \( x \) CONTAINS \( y \).

A node \( x \) IMMEDIATELY DOMINATES a node \( y \) if and only if \( x \) dominates \( y \) and there is no intervening node \( z \) such that \( z \) dominates \( y \) but \( z \) does not dominate \( x \).

In other words: \( x \) immediately dominates \( y \) if \( x \) is the first node dominating \( y \).

If \( x \) immediately dominates \( y \) then we call \( x \) the MOTHER of \( y \), and we call \( y \) the DAUGHTER of \( x \). If two nodes have the same mother, they are called SISTERS.

Each node in a tree is either:
- a TERMINAL NODE
- a NON-TERMINAL NODE.

Terminal nodes are nodes with no daughters.
A node $x$ EXHAUSTIVELY DOMINATES a set of nodes $\{a, b, \ldots, n\}$ if and only if:
• $x$ immediately dominates all members of the set $\{a, b, \ldots, n\}$, &
• no node immediately dominated by $x$ is not in the set $\{a, b, \ldots, n\}$.

What does $D$ exhaustively dominate?
$\{G, H\}$

What does $B$ exhaustively dominate the set of nodes $\{E, F, I, J\}$?
$\textbf{NO!}$

Informal definition:
A constituent is a group of words that function as a unit.

Formal definition:
A constituent is any set of nodes that is exhaustively dominated by a single node.

A node $x$ PRECEDES a node $y$ if and only if
• $x$ does not dominate $y$,
• $y$ does not dominate $x$,
• $x$ is to the left of $y$,
• every node dominating $x$ either dominates or precedes $y$.

What nodes precede $C$?
$\{B, E, F, I, J\}$

What nodes does $C$ precede?
$\{D, G, H, K, L, M\}$

Does $J$ precede $F$?
$\textbf{YES}$

Does $G$ precede $K$?
$\textbf{YES}$

Does $A$ precede $M$?
$\textbf{NO!}$

(A dominates $M$)

A node $x$ C-COMMANDS a node $y$ if and only if
• $x$ does not dominate $y$,
• $y$ does not dominate $x$,
• the first branching node dominating $x$ also dominates $y$.

In other words:
a node c-commands only her sisters and the nodes dominated by her sisters!

What nodes does $B$ c-command?
$\{C, D, G, H, K, L, M\}$

What nodes does $F$ c-command?
$\textbf{NO!}$

Does $E$ c-command $F$?
$\textbf{YES}$

Does $F$ c-command $G$?
$\textbf{NO!}$

We can even define some grammatical concepts and relations in terms of structural relations is a tree:

‘Subject’: NP daughter of S
‘Object’: NP daughter of VP
‘Object of a Preposition’: NP daughter of PP

‘Constituent’

Informal definition:
A constituent is a group of words that function as a unit.

Formal definition:
A constituent is any set of nodes that is exhaustively dominated by a single node.

‘Is this a tree?’

Technically, yes! And that’s a problem.
We don’t our PS rules to be able to generate trees like this. (If they could, the rules would not be able to make predictions about word order.)

We can use the notion of precedence to constrain tree-structure!

No Crossing Branches Constraint:
If a node $x$ precedes a node $y$ then all nodes dominated by $x$ must precede $y$ and all nodes dominated by $y$. 

Subject: NP daughter of S
Object: NP daughter of VP
Object of a Preposition: NP daughter of PP
Summary

• Syntactic trees are a special type of mathematically defined graph, consisting of nodes and edges (= branches)
• Elements of trees exhibit various different structural relations among one another, and it can be helpful to refer to these
  – Dominance (one node ‘containing’ another node)
  – Precedence (one node ‘coming before’ another node)
  – C-command: (one node ‘being a sister or aunt’ of another node)
• We can refer to these relations to:
  – define constituency,
  – place restrictions on trees (No Crossing Branches Constraint),
  – define grammatical relations,
  – many other things that you will learn about later!

See you next time,