Grammar Implementation with Lexicalized Tree Adjoining Grammars and Frame Semantics

Syntactic analyses

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  - correct predictions wrt. processing complexity

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1. The derivation tree
2. Design principles for elementary trees
3. Sample derivations
   - NP and PP complements
   - Sentential complements and long-distance dependencies
   - Modifiers
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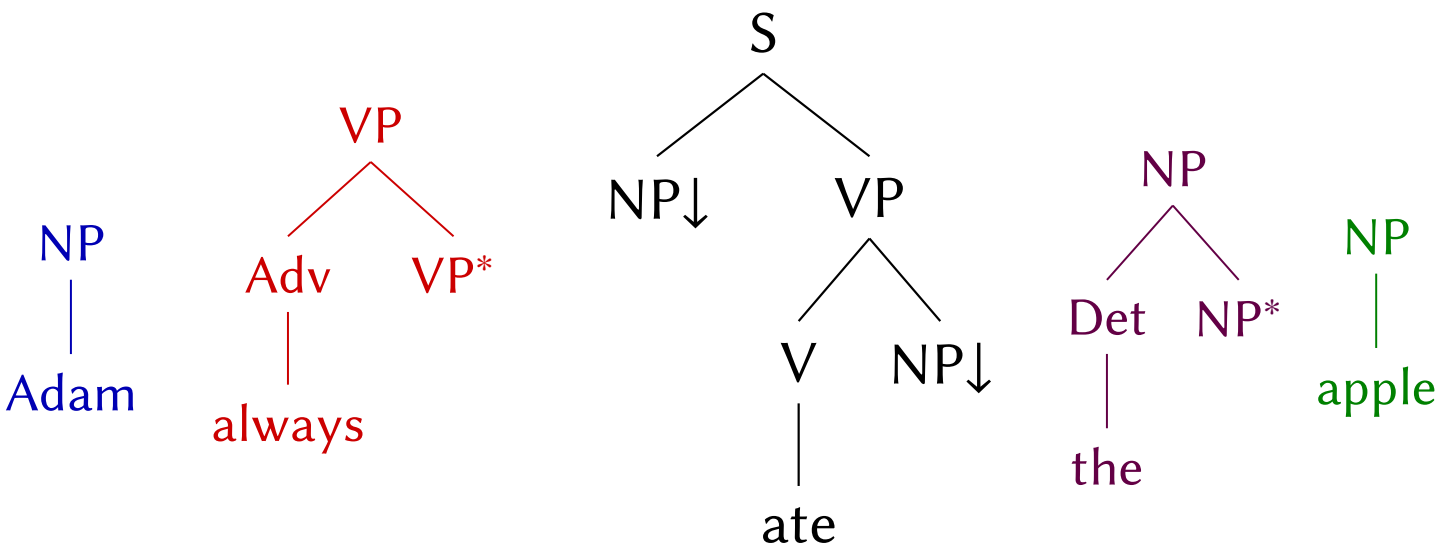

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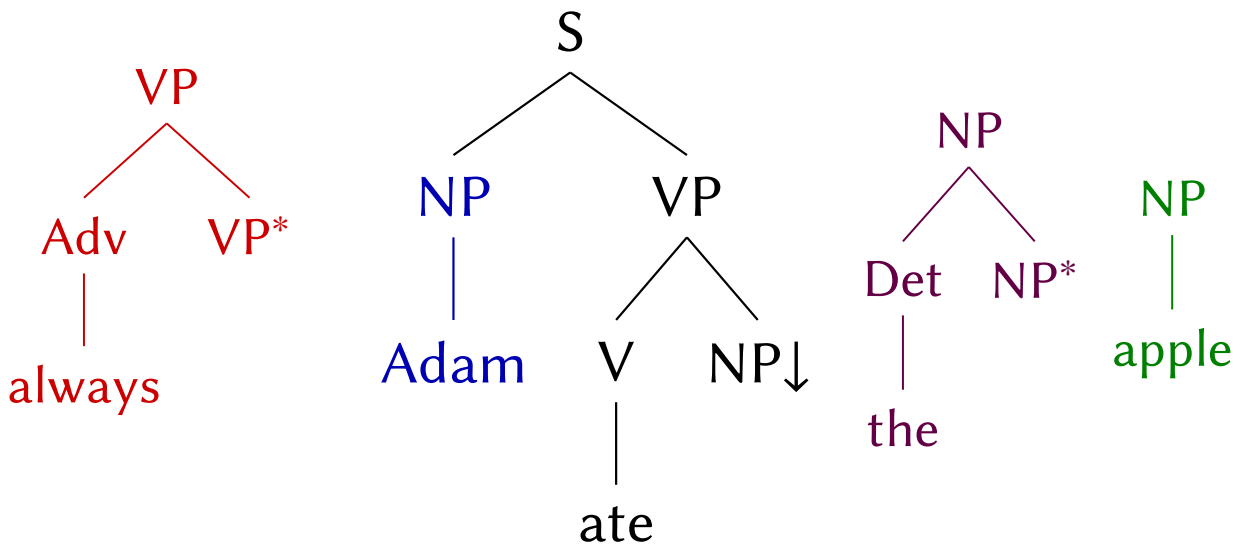

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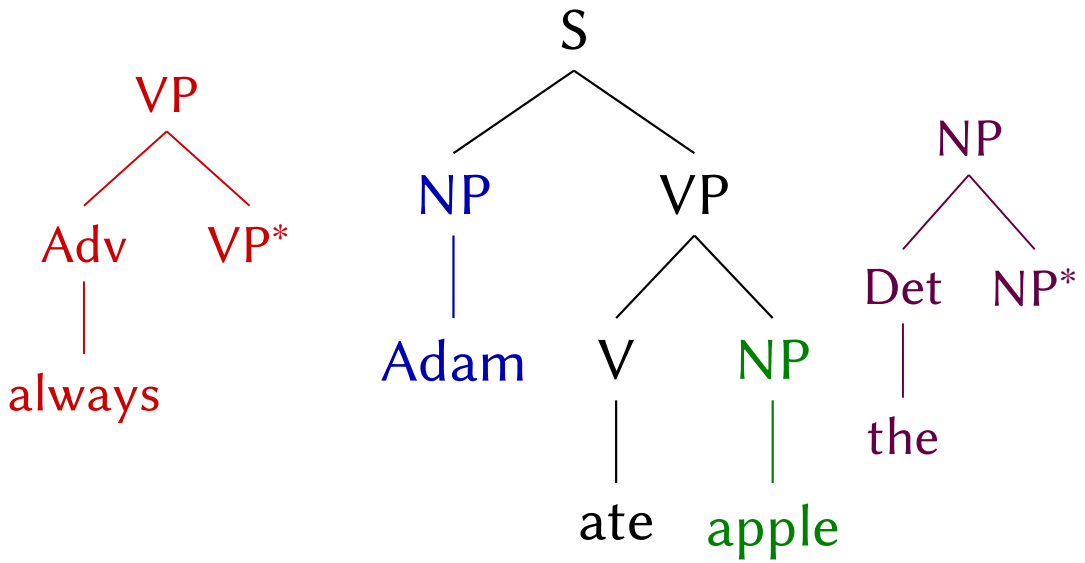

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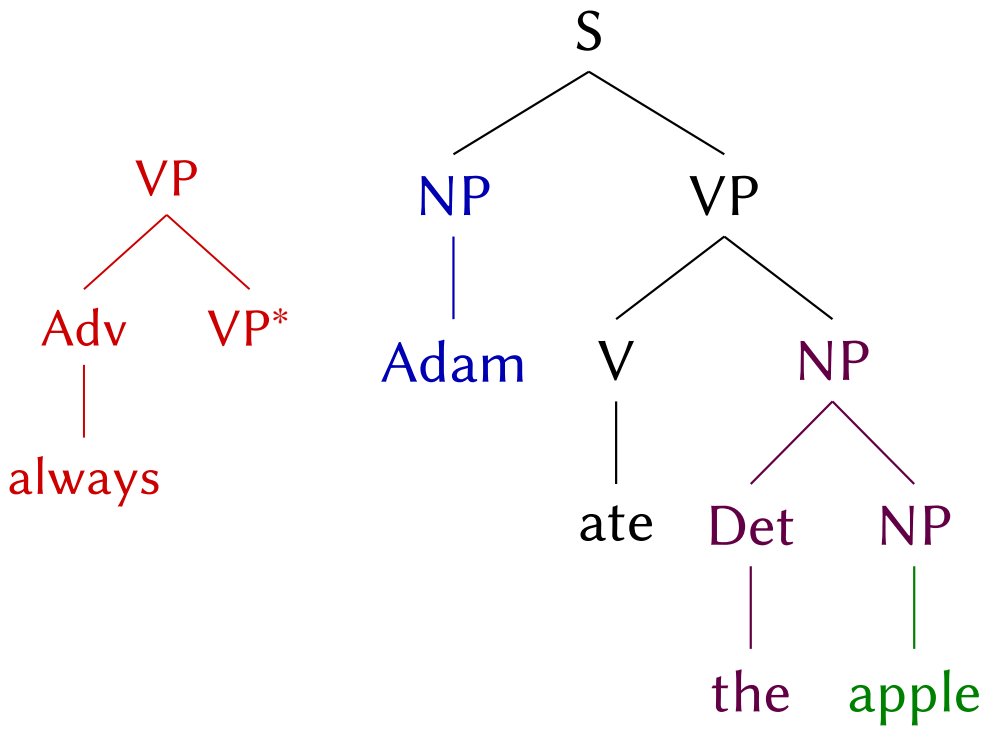

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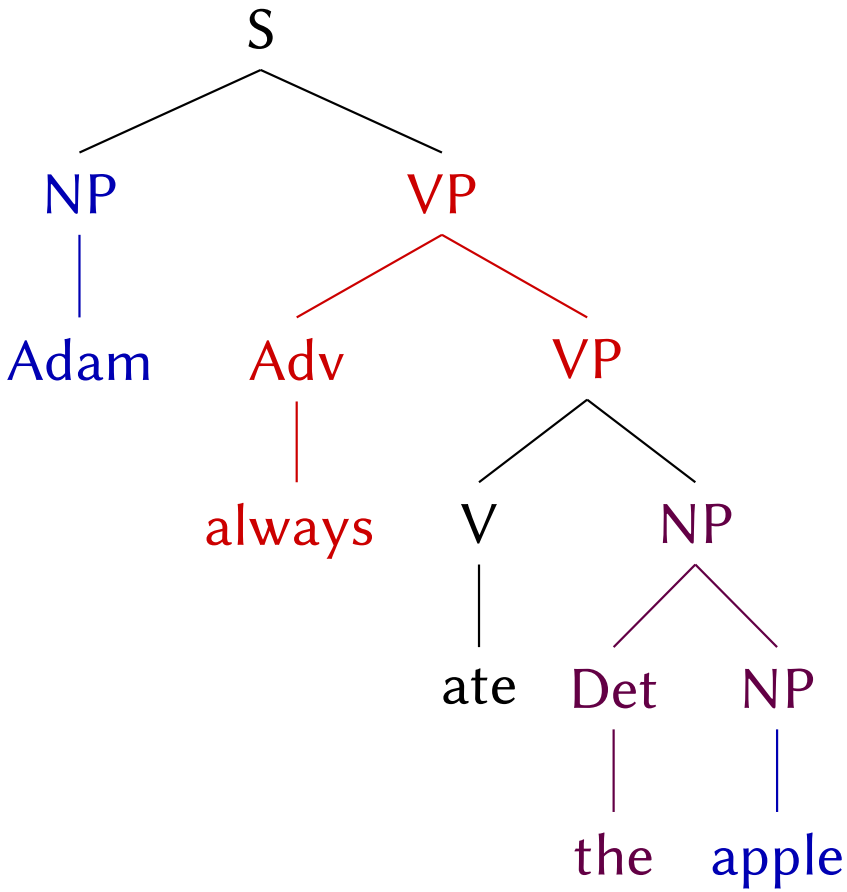

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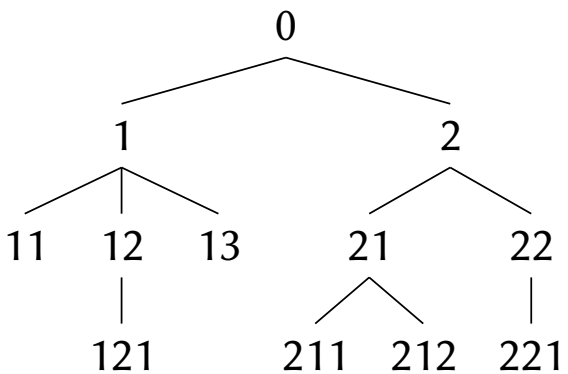
Whenever an elementary tree γ rewrites the node at Gorn address p in the elementary tree γ', there is an edge from γ' to γ labeled with p.

Note that in principle derivation trees are unordered. As a convention, daughters are ordered according to their addresses.

Derivation trees

For the node addresses of elementary trees, **Gorn addresses** are used:

- the root has address ϵ (or 0)
- the ith daughter of the node with address p has address pi.



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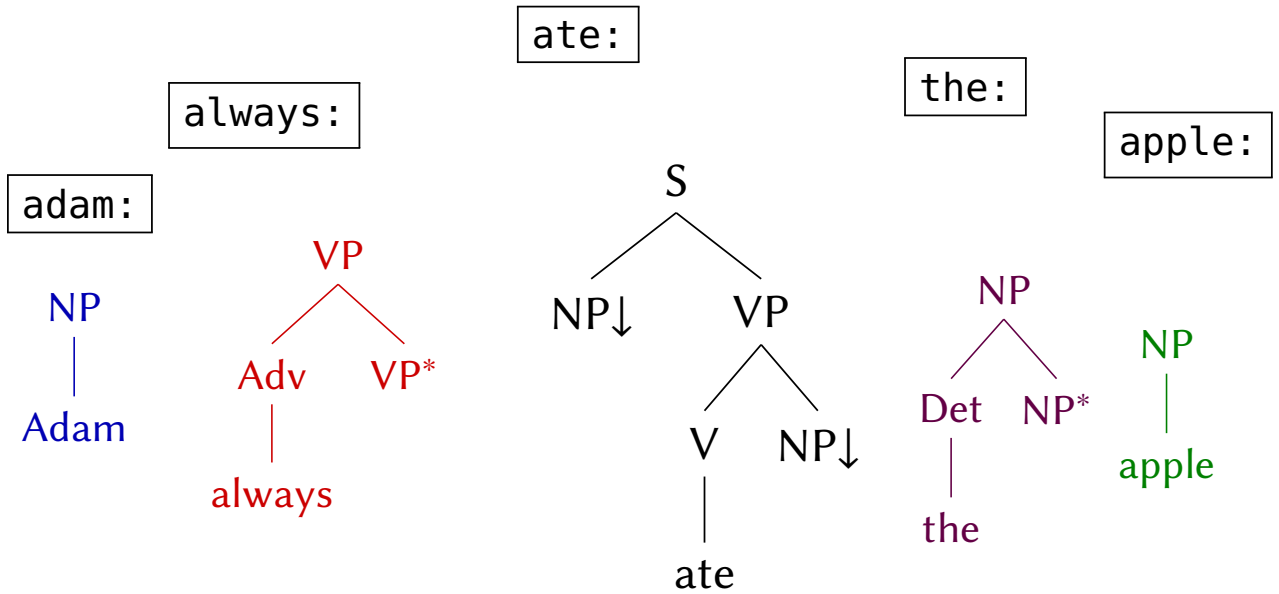

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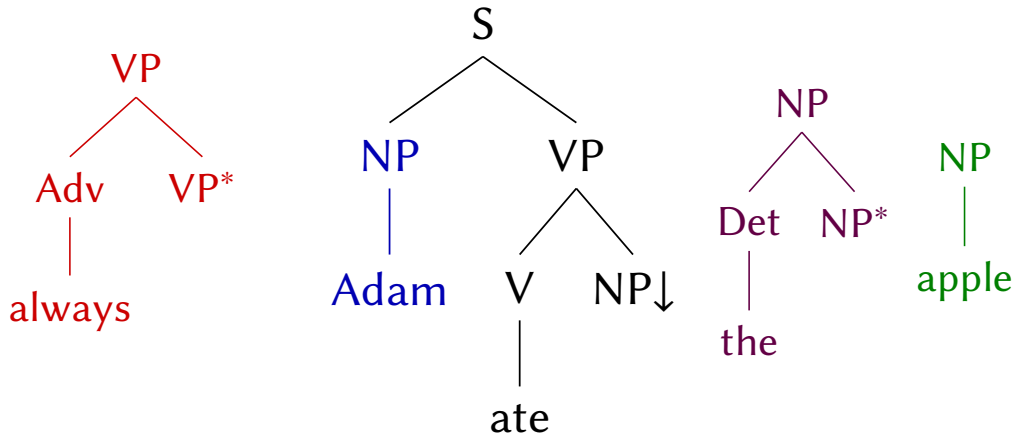

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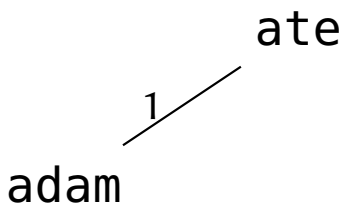

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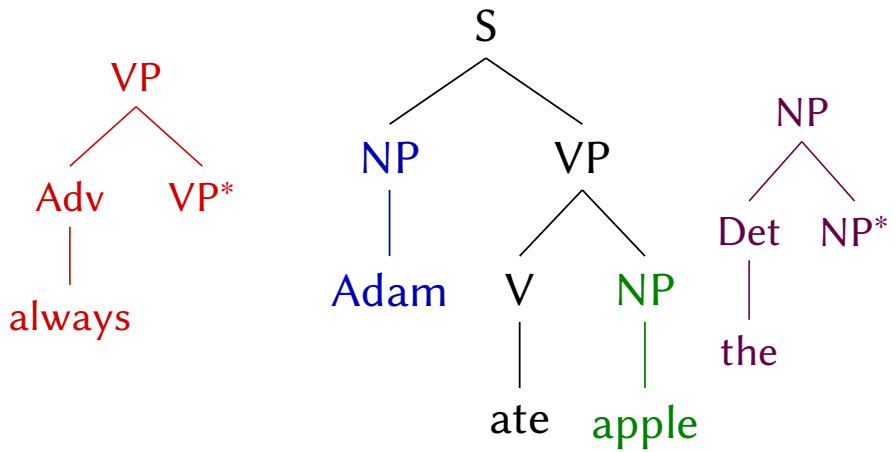

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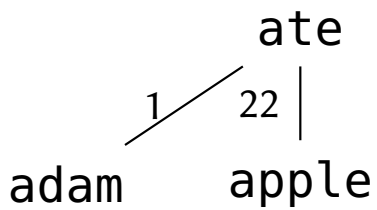

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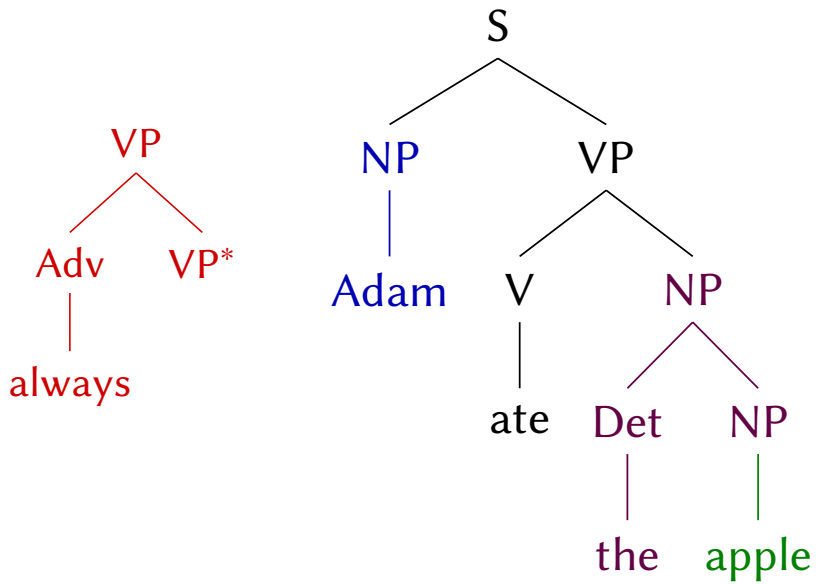

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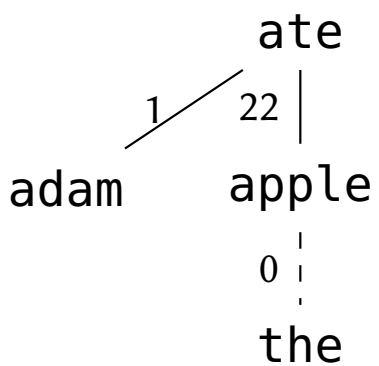

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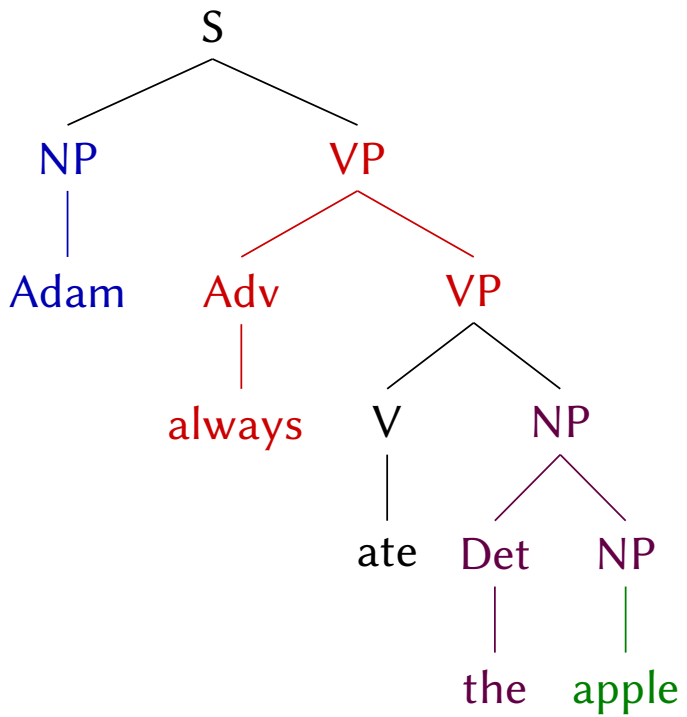

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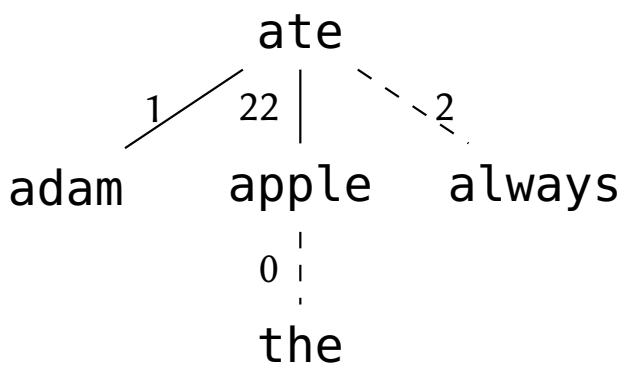

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[Schabes & Joshi (1990); Joshi & Schabes (1991)]

Recall: reasons for lexicalization

- **Formal properties:** A finite lexicalized grammar provides finitely many analyses for each string (finitely ambiguous).
- **Linguistic properties:** Syntactic properties of lexical items can be accounted for more directly.
- **Parsing:** The search space during parsing can be delimited (grammar filtering).

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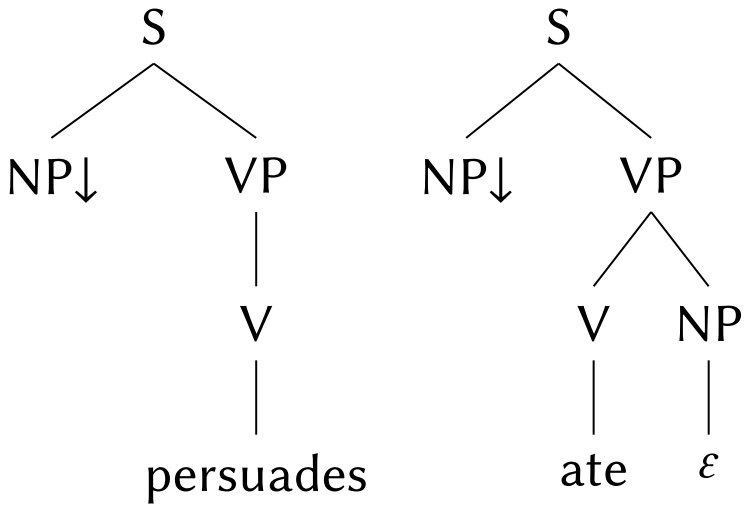
“expressed within an elementary tree”

- terminal leaf (i.e. lexical anchor)
- nonterminal leaf (substitution node and footnode)
- marking an inner node for obligatory adjunction

Syntactic design principles (2): FTH

Examples of ill-formed elementary trees:



Complex primitives

Joshi (2004):

Complicate locally, simplify globally.

"[...] start with complex (more complicated) primitives, which capture directly some crucial linguistic properties and then introduce some general operations for composing these complex structures (primitive or derived). What is the nature of these complex primitives? In the conventional approach the primitive structures (or rules) are kept as simple as possible. This has the consequence that information (e.g., syntactic and semantic) about a lexical item (word) is distributed over more than one primitive structure. Therefore, the information associated with a lexical item is not captured locally, i.e., within the domain of a primitive structure."
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The syntactic heads in an elementary tree and their projections must form the extended projection of a single lexical head.

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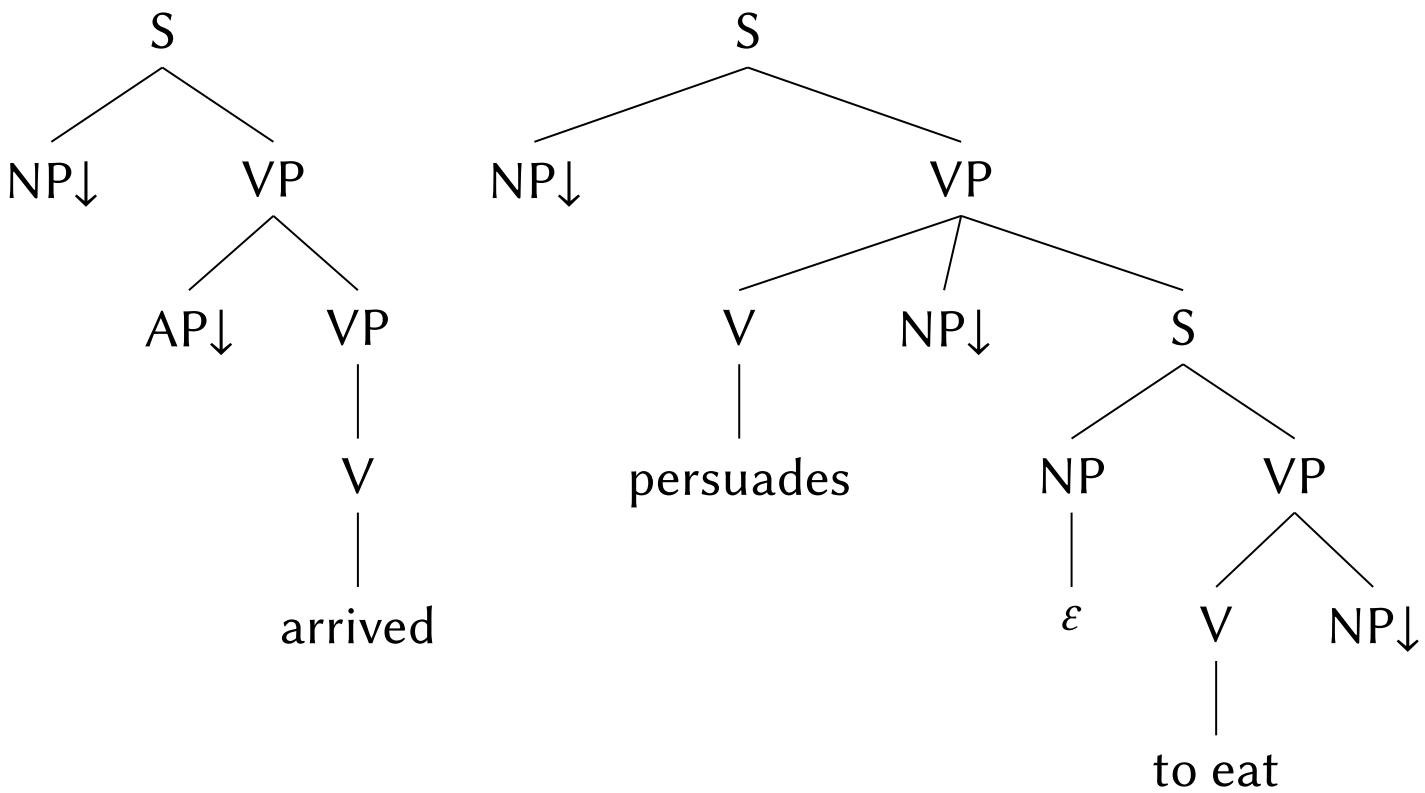

Syntactic design principles (4): θ-Criterion for TAG

Thematic role (θ-role)

the semantic relationship of an argument with its predicate is expressed through the assignment of a role by the predicate to the argument. Different theta-roles have different labels, such as AGENT, THEME, PATIENT, GOAL, SOURCE, EXPERIENCER etc.

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  - *kicked* $\rightsquigarrow$ predicate
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Syntactic design principles (4): θ-Criterion for TAG

θ-Criterion (TAG version)

a. If H is the lexical head of an elementary tree T, H assigns all of its θ-roles in T.

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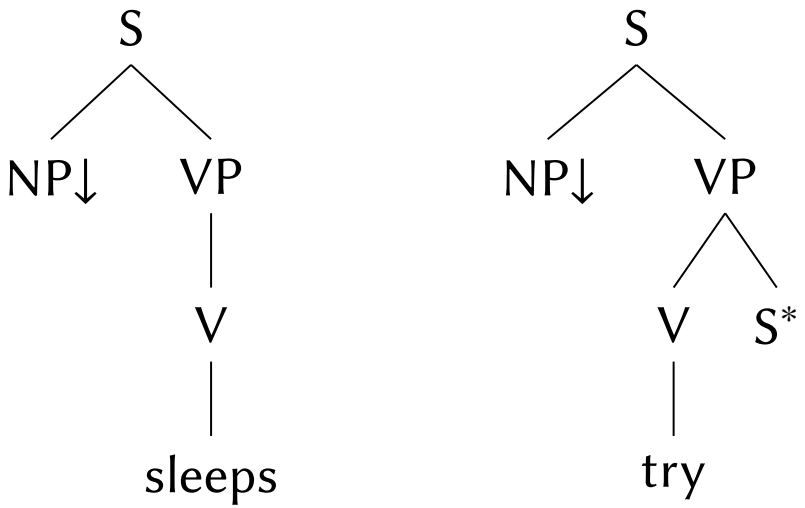

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Design principle of economy

The elementary trees are shaped in such a way, that the size of the elementary trees and the size of the grammar is minimal.

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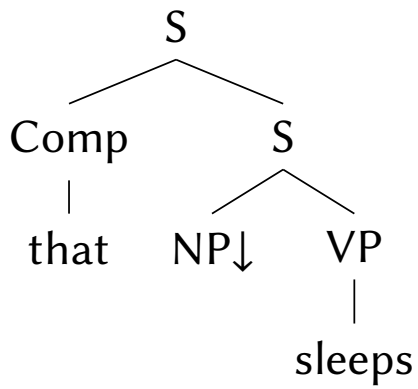

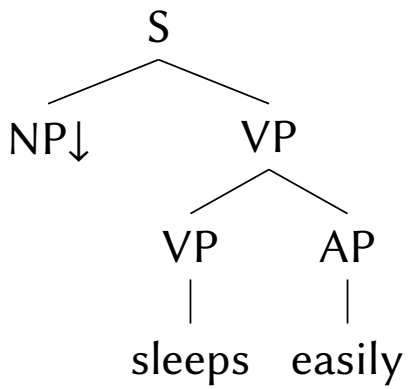

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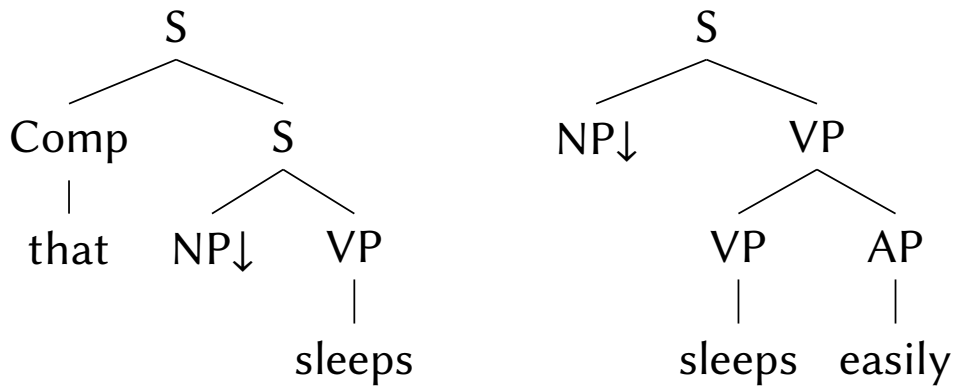
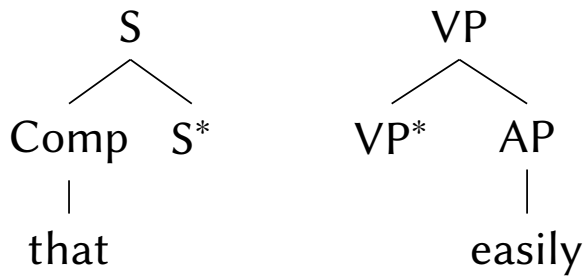


- or by separate auxiliary trees (e.g., XTAG grammar)



⇒ Footnodes/Adjunctions indicate both complementation and modification.

⇒ Enhancement of the CETM: [see Abeillé & Rambow (2000)]

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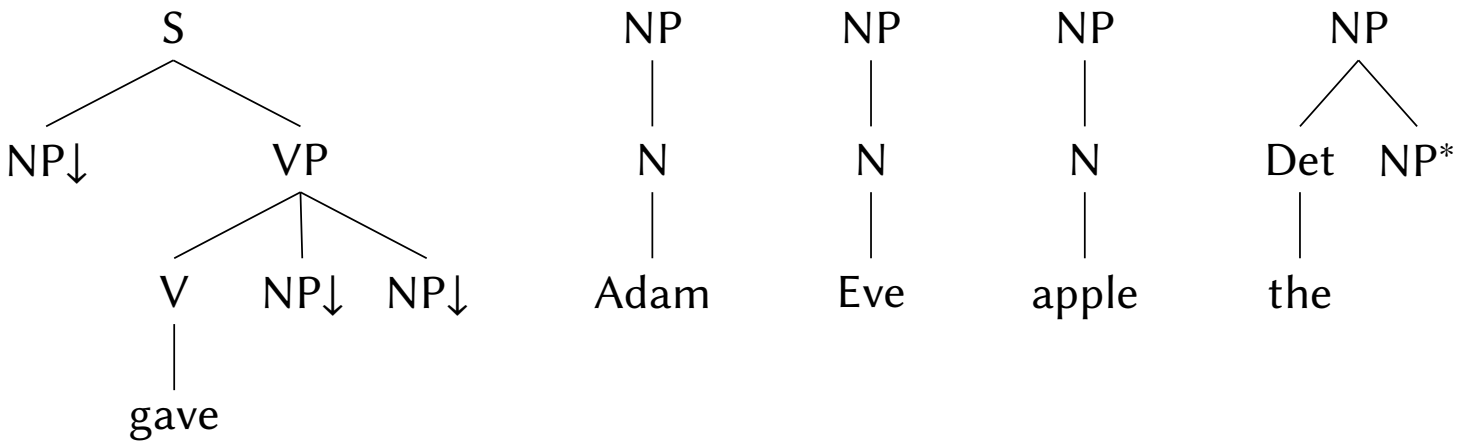

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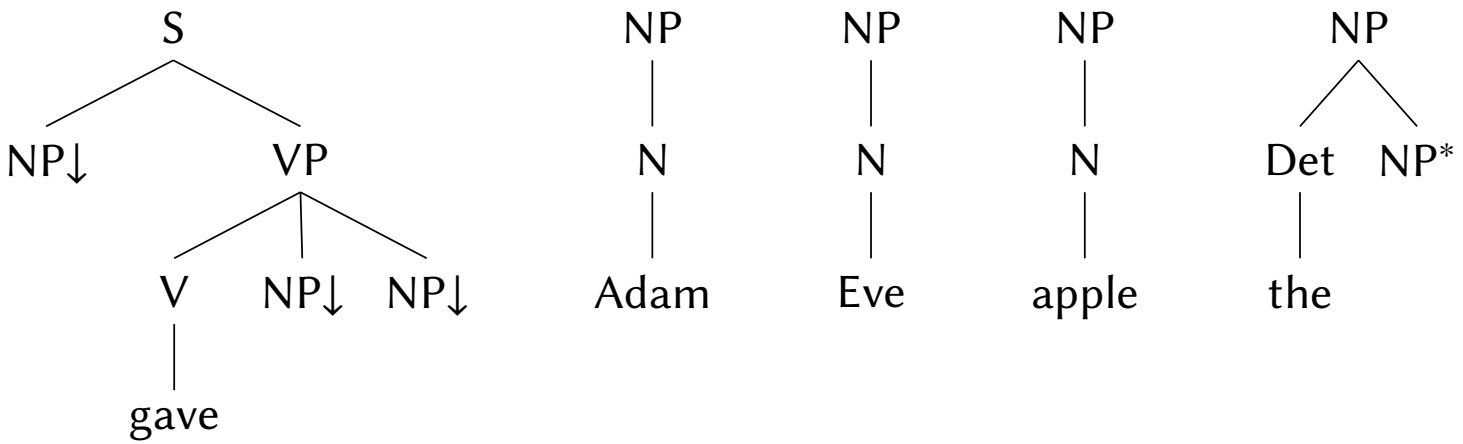

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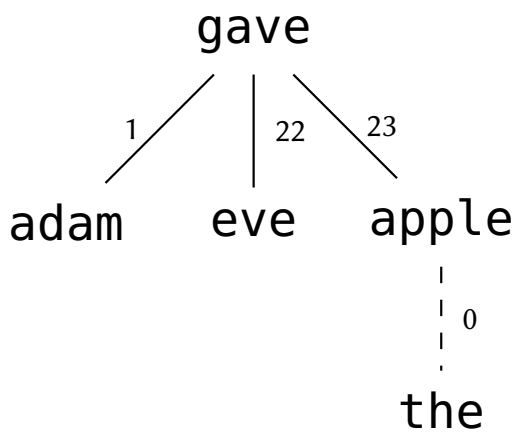

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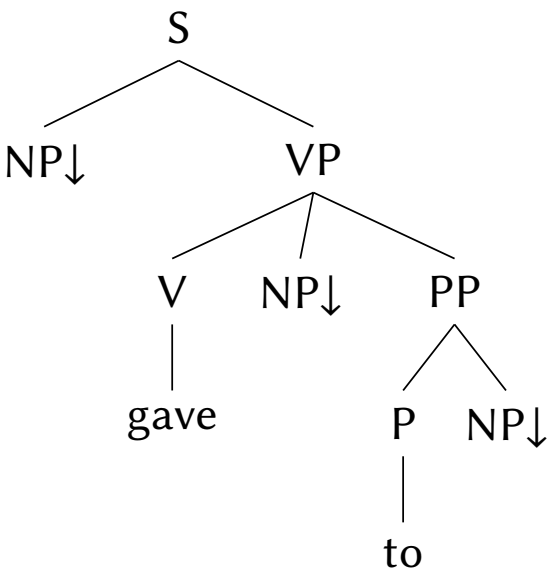

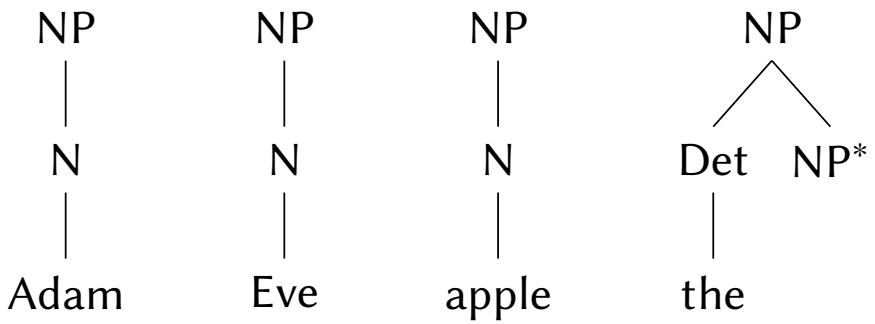

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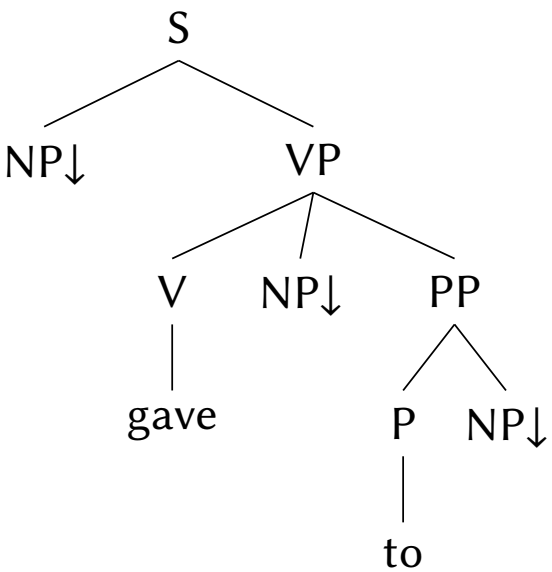
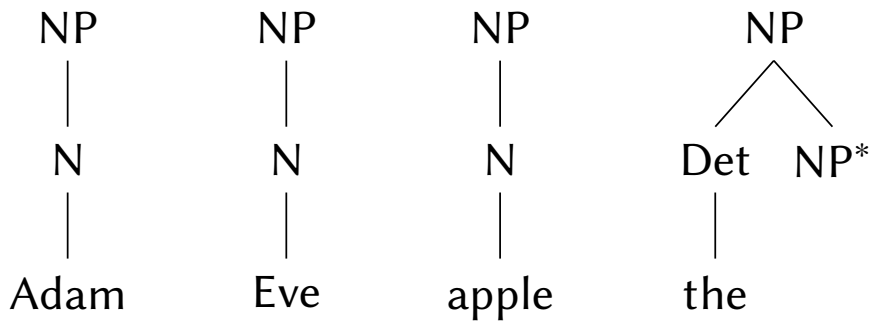
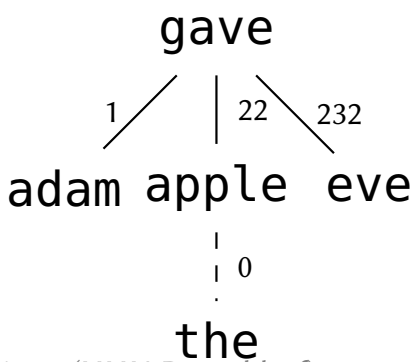




Derivation tree:



Sample derivations: Sentential complements

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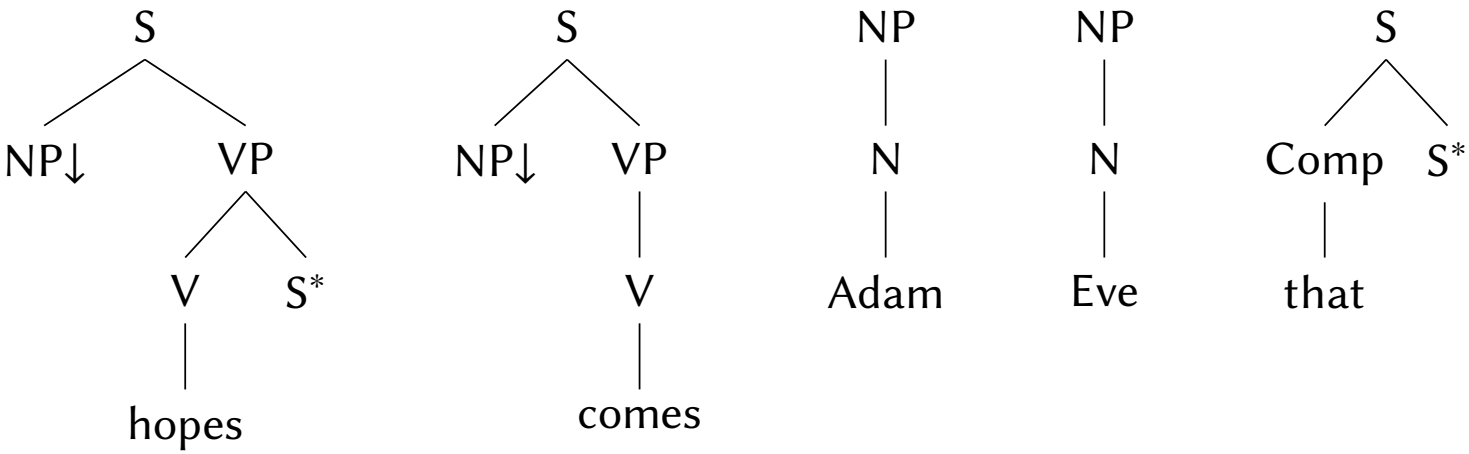

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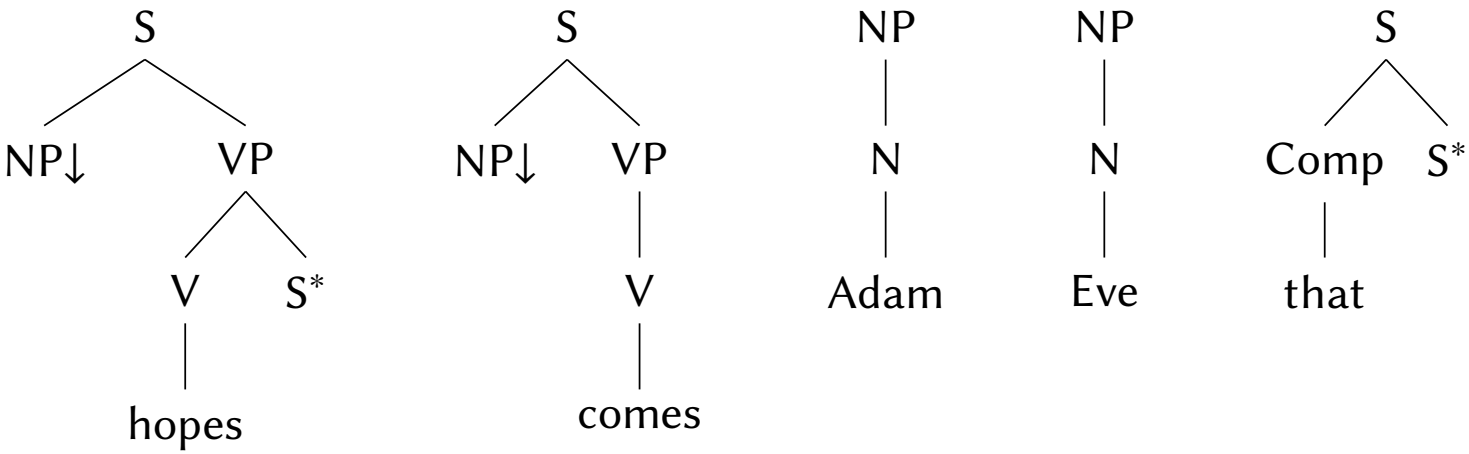

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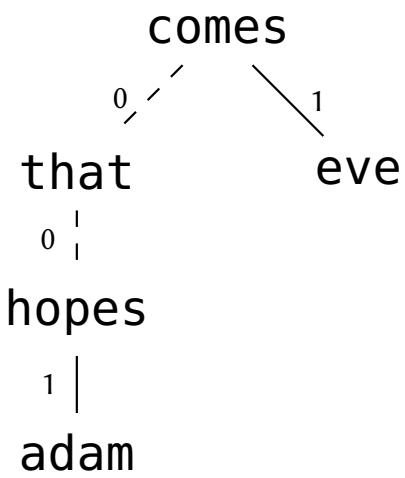
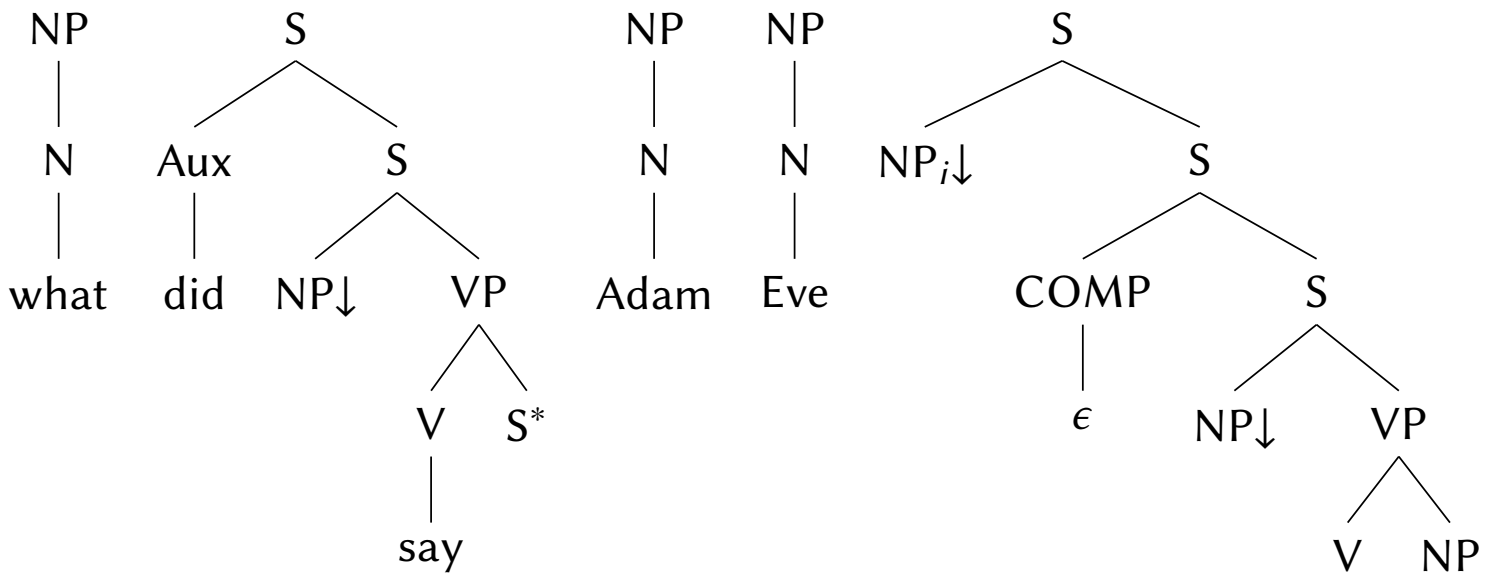


Sample derivations: long-distance dependency

(4) What$_i$ did Adam say (that) Eve ate $\_i$?



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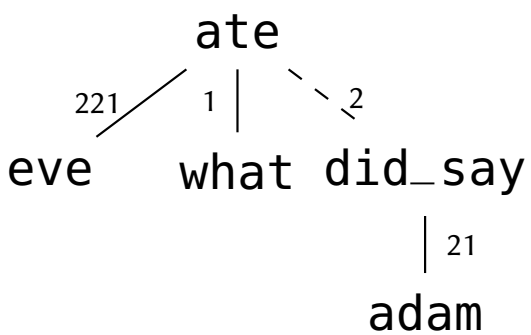

Sample derivations: Modifiers

(5) The good student participated in every course during the semester.

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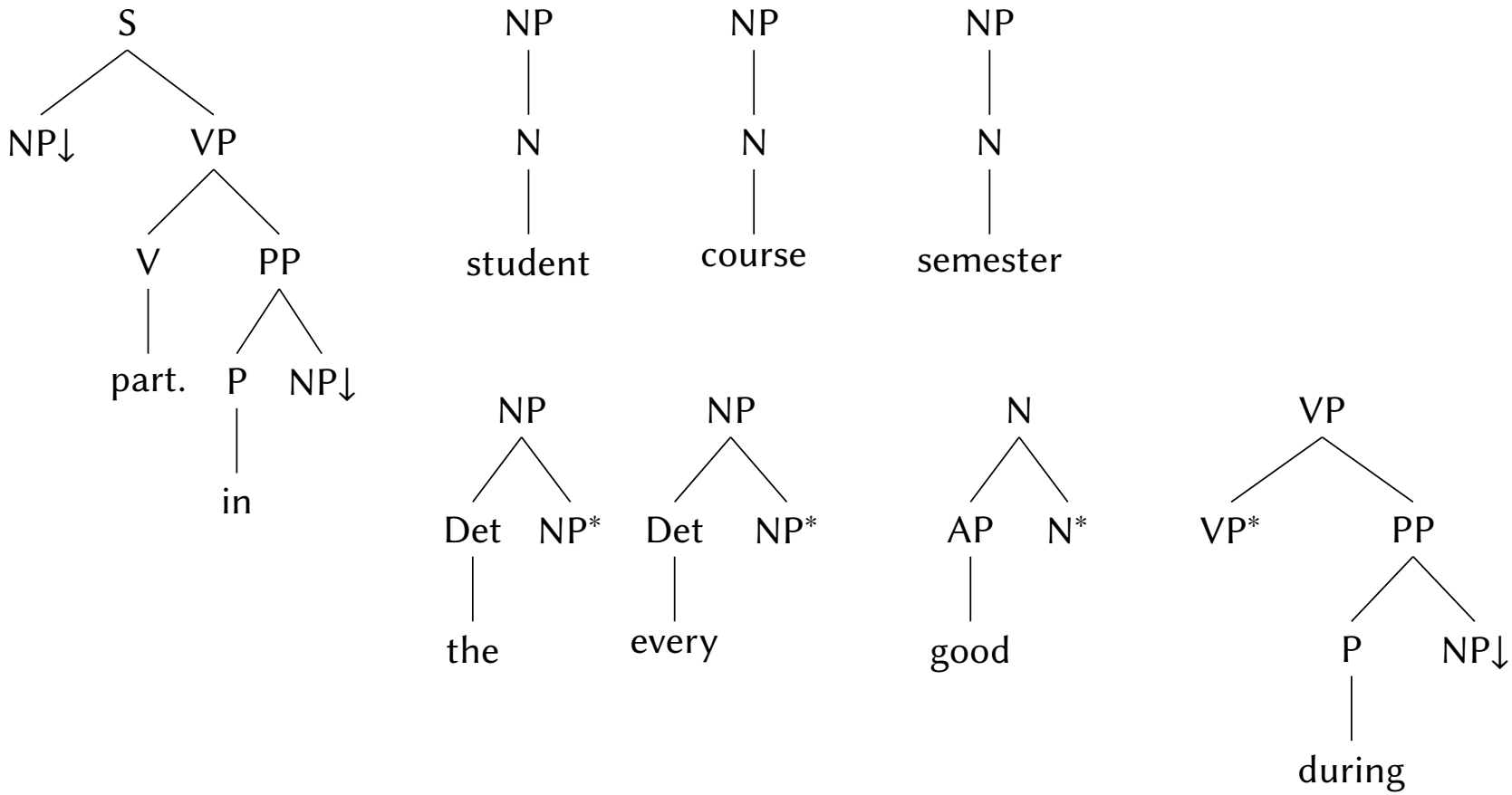

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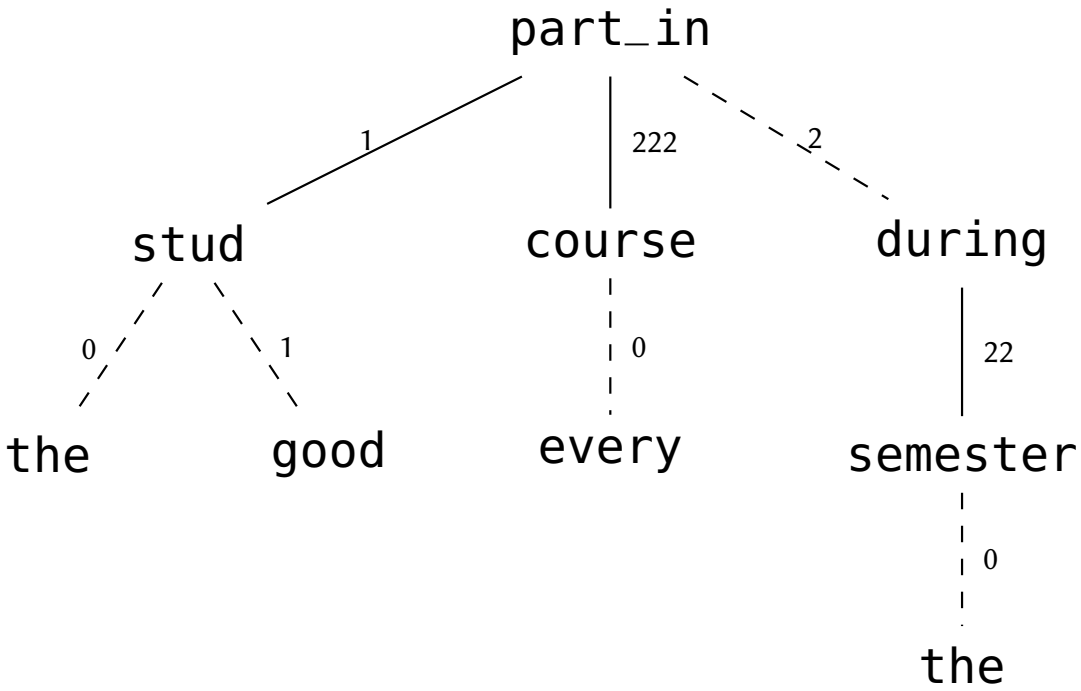

Outline of today's course

1. The derivation tree
2. Design principles for elementary trees
3. Sample derivations
   - NP and PP complements
   - Sentential complements and long-distance dependencies
   - Modifiers
4. Feature based TAG
5. Summary and outlook

Feature structures

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Subsumption ($F_1 \sqsubseteq F_2$)

A feature structure F_1 subsumes ($\sqsubseteq$) another feature structure F_2, iff all the information that is contained in F_1 is also contained in F_2.

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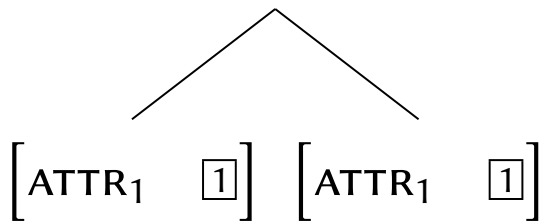

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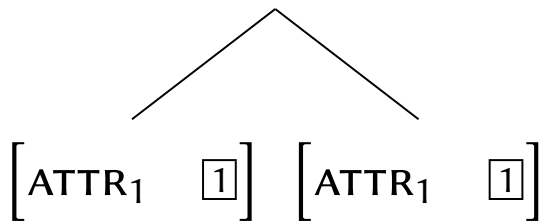

Note that

- feature structues in FTAG are untyped. (In contrast to frames, see tomorrow's course.)
- the feature geometry is such that there is only a finite number of possible feature structures
- therefore, FTAG can be shown to be strongly equivalent to TAG without feature structures

Unification: examples

- $$\begin{bmatrix} \text{AGR} & \begin{bmatrix} \text{NUM} & \text{sg} \end{bmatrix} \\ \text{SUBJ} & \begin{bmatrix} \text{AGR} & \begin{bmatrix} \text{NUM} & \text{sg} \end{bmatrix} \end{bmatrix} \end{bmatrix} \sqcup \begin{bmatrix} \text{SUBJ} & \begin{bmatrix} \text{AGR} & \begin{bmatrix} \text{PERS} & 3 \end{bmatrix} \end{bmatrix} \end{bmatrix} = \begin{bmatrix} \text{AGR} & \begin{bmatrix} \text{NUM} & \text{sg} \end{bmatrix} \\ \text{SUBJ} & \begin{bmatrix} \text{AGR} & \begin{bmatrix} \text{NUM} & \text{sg} \\ \text{PERS} & 3 \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

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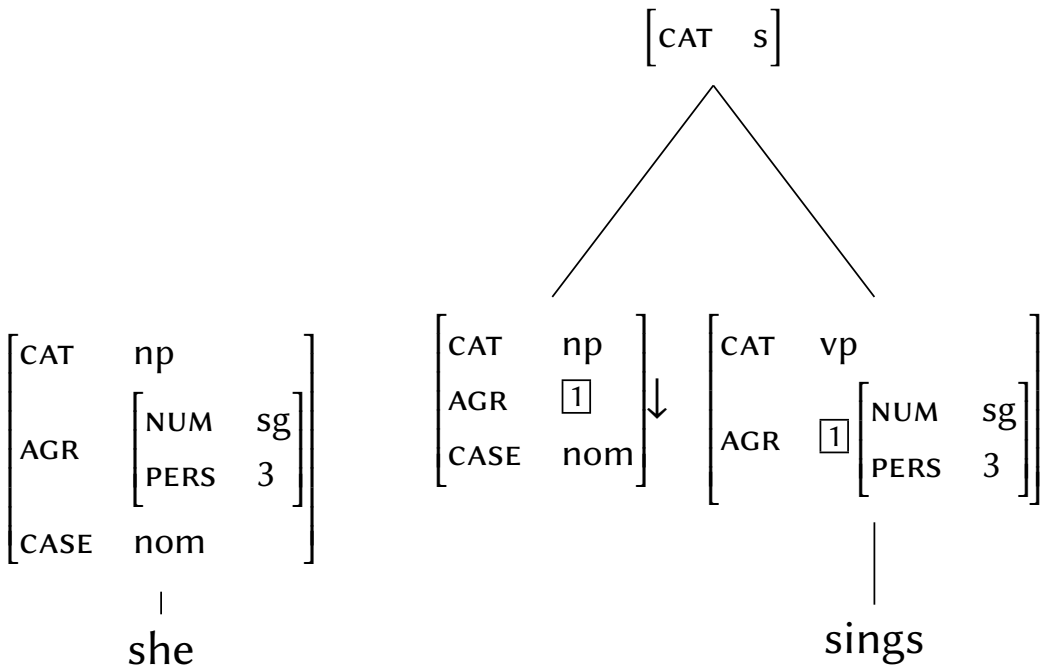

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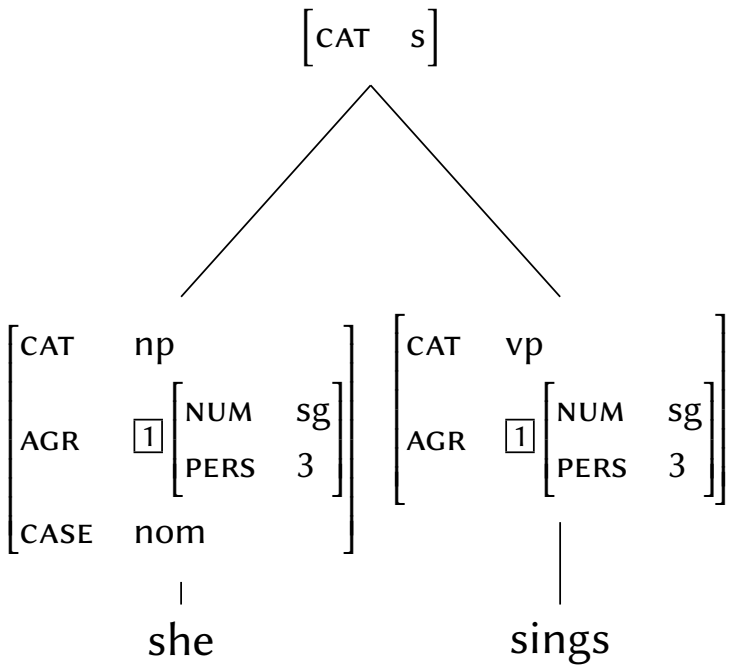

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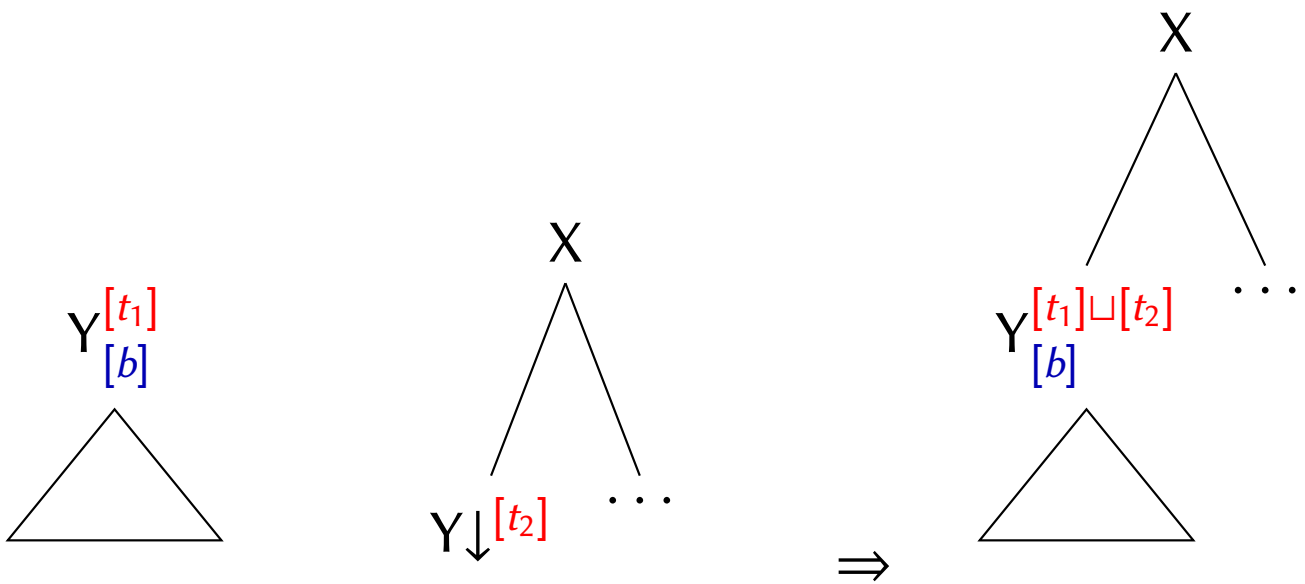
- at the final derived tree top and bottom features are unified for all nodes

FTAG: Substitution

Substitution in FTAG

The top features of the root of the tree to substitute unify with the top features of the substitution node.

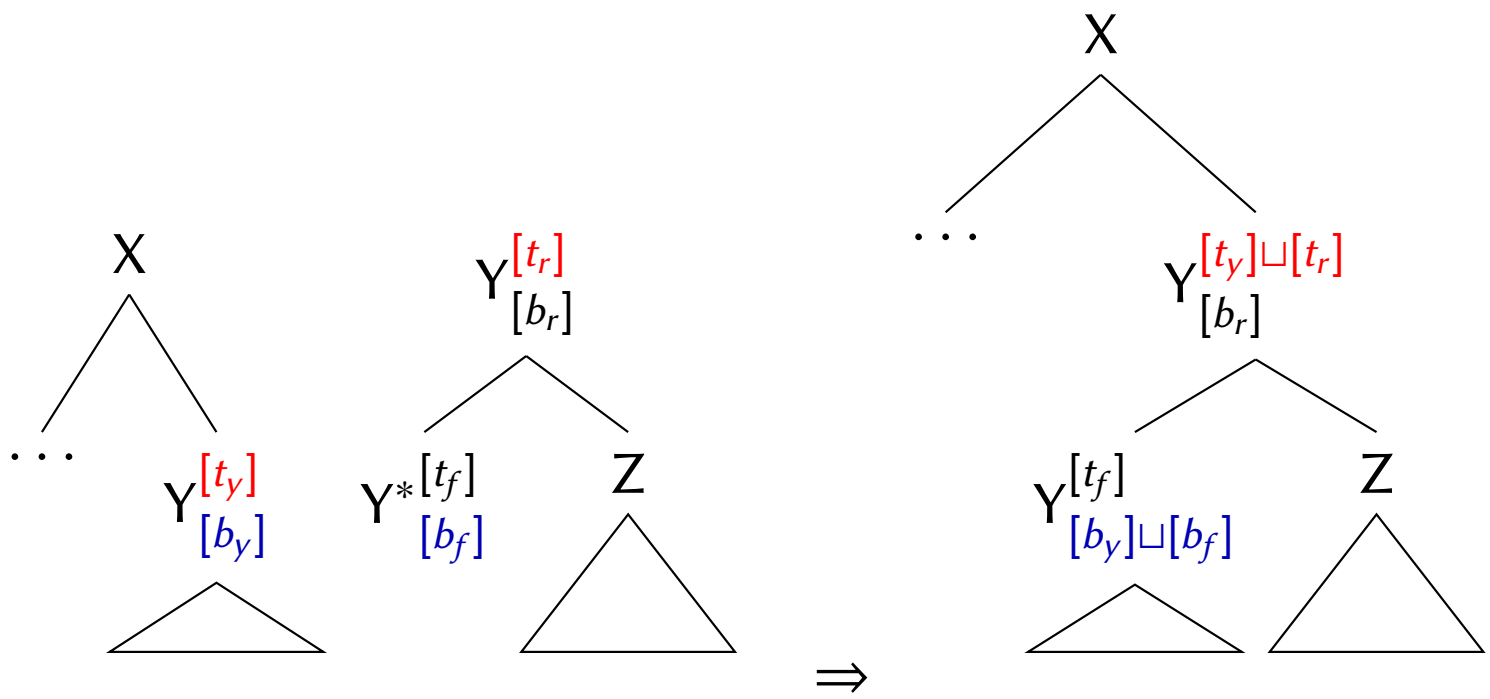


- substitution nodes (Y↓) have only top features

FTAG: Adjunction

Adjunction in FTAG

The top features of the root of the auxiliary tree unify with the top features of the adjunction node, and the bottom features of the footnode of the auxiliary tree unify with the bottom features of the adjunction node.



Adjunction constraints

Modeling adjunction constraints with features:

Adjunction constraints

Modeling adjunction constraints with features:

- SA: top and bottom are unifiable

$$\begin{bmatrix}\textsc{cat} & \text{vp}\end{bmatrix}$$
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Adjunction constraints

Modeling adjunction constraints with features:

- SA: top and bottom are unifiable

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- OA + SA: feature mismatch between top and bottom

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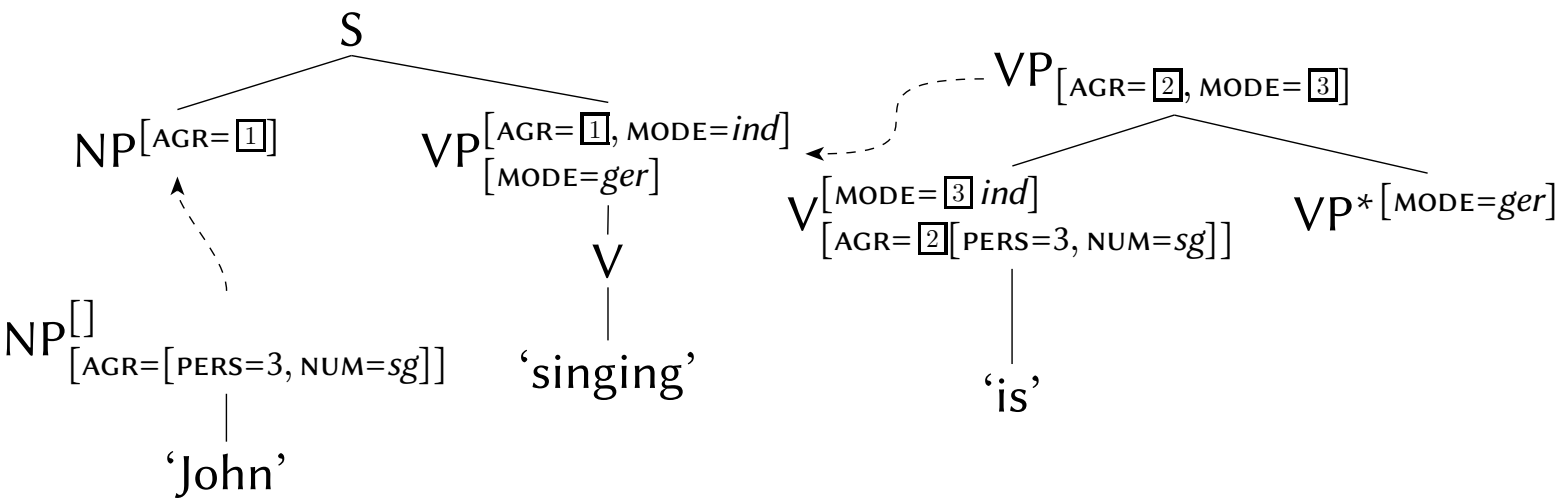
- NA: top and bottom are unifiable, but there is no auxiliary tree in the grammar that can be unified with them

FTAG example for OA

(6) John is singing.



- The features are inspired by the XTAG grammar (XTAG Research Group 2001).
- The CAT feature is taken to be special, in particular it is usually the same in top and bottom. We therefore notate it as the main category of a node, outside the feature structures.

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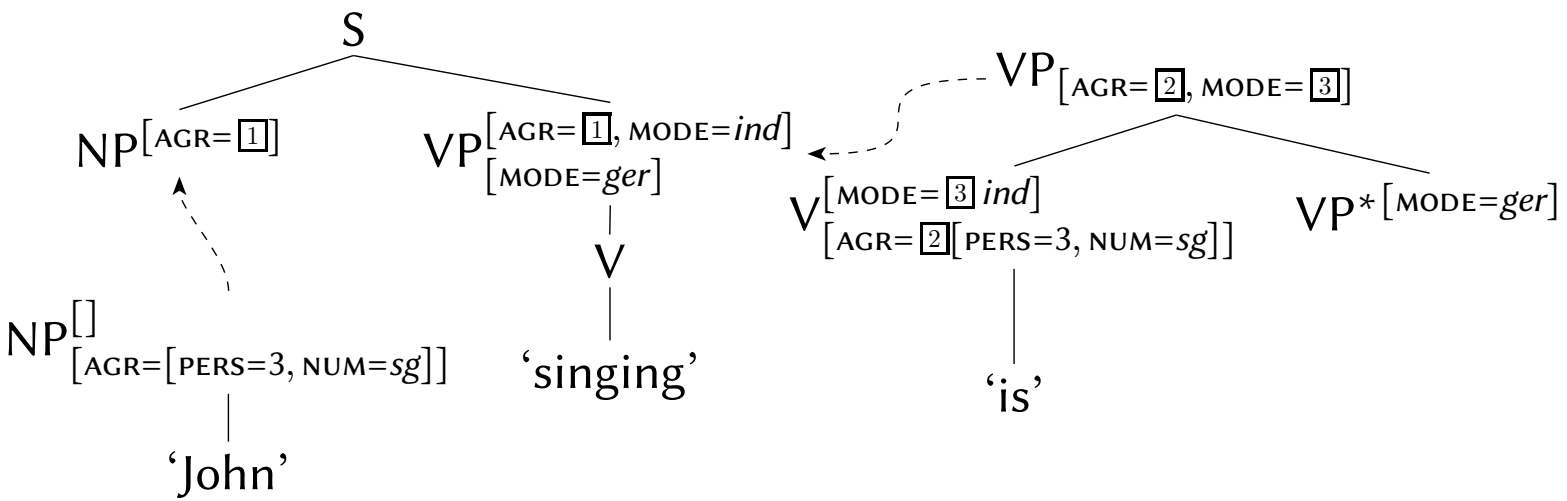
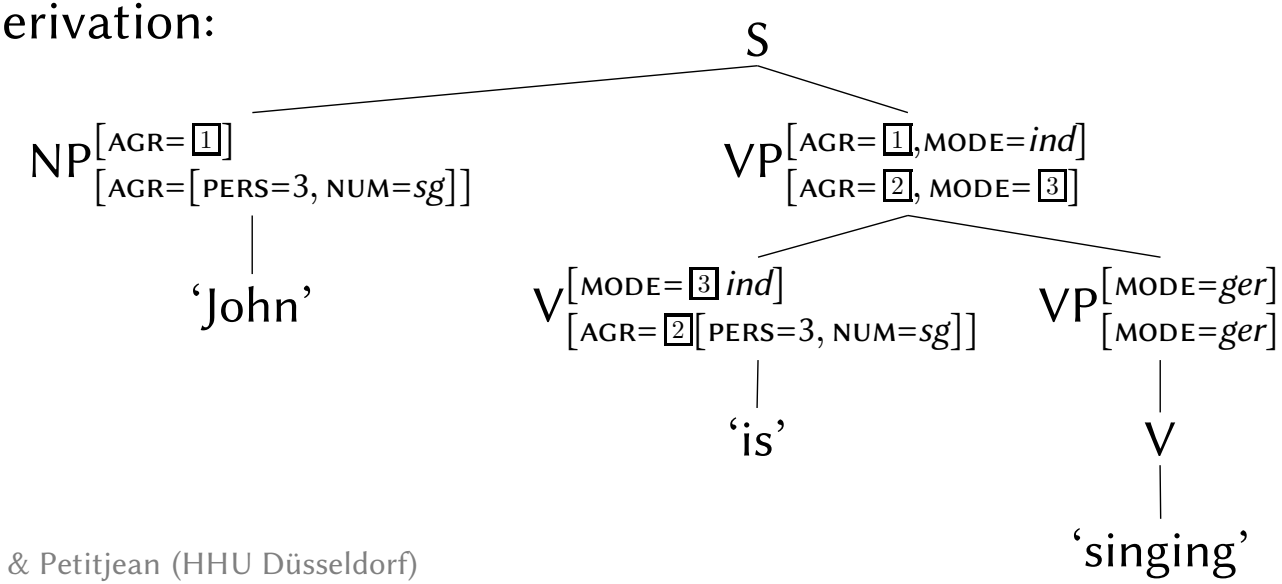


Result of derivation:



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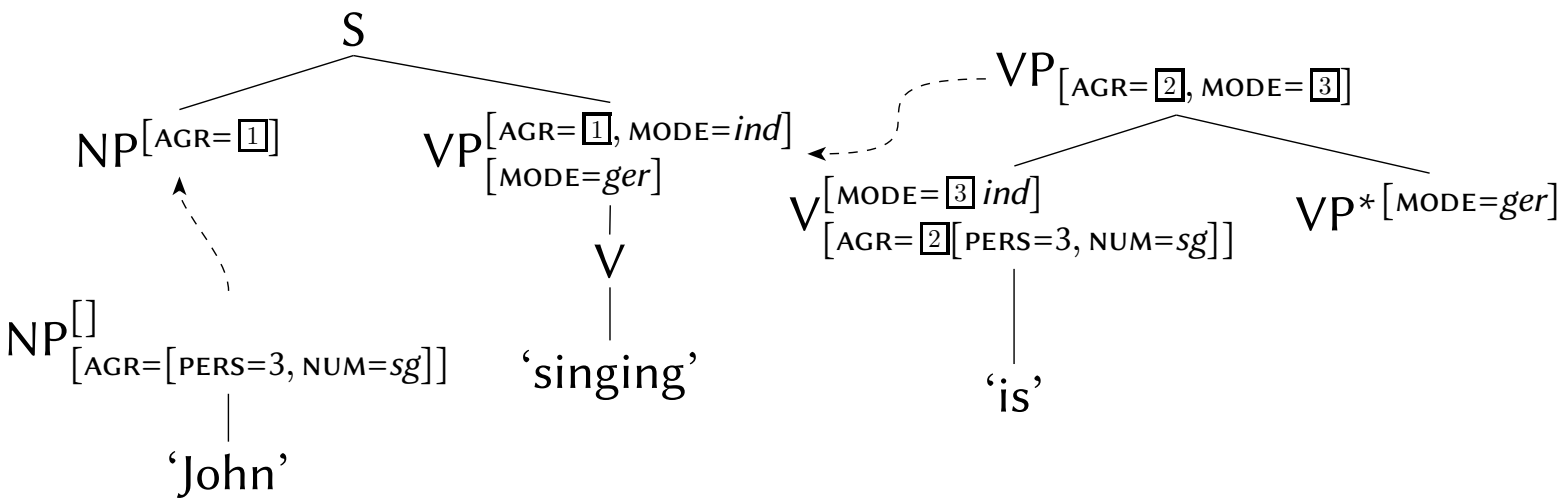
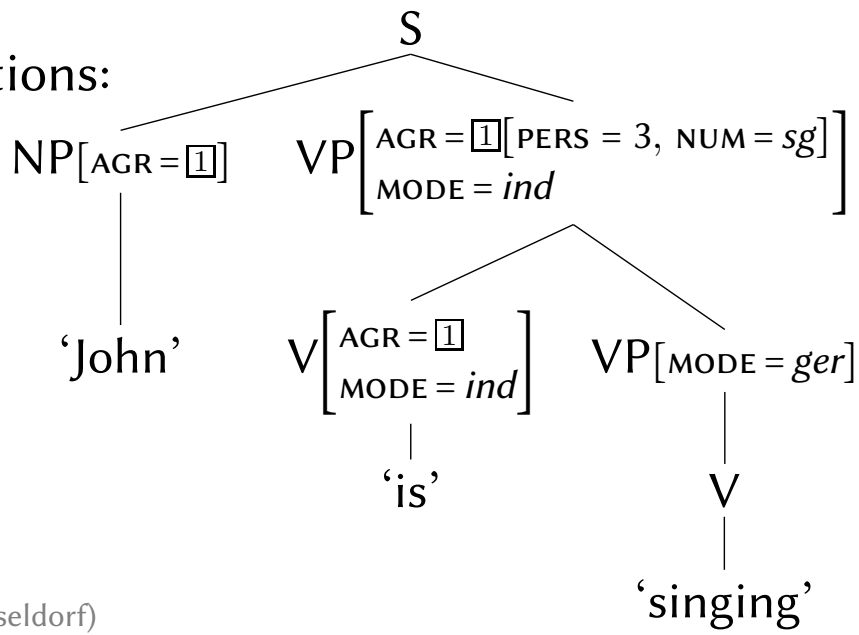


After top-bottom unifications:



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- features of case-assignment:
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    ⇒ Ns, NPs
  - ASSIGN-CASE with values: nom | acc | none
    ⇒ case assigners (prepositions, verbs) and S, VP, PP nodes that dominate them

Case assignment

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b. *her laughed

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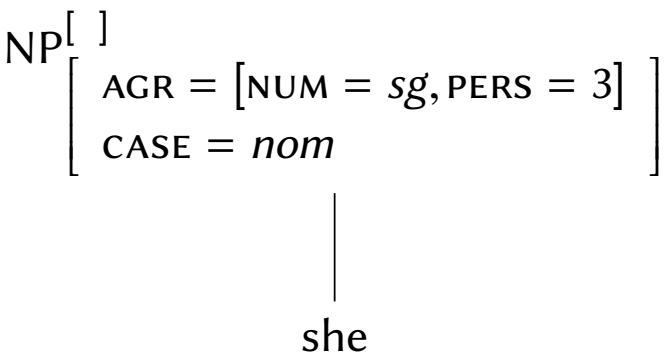

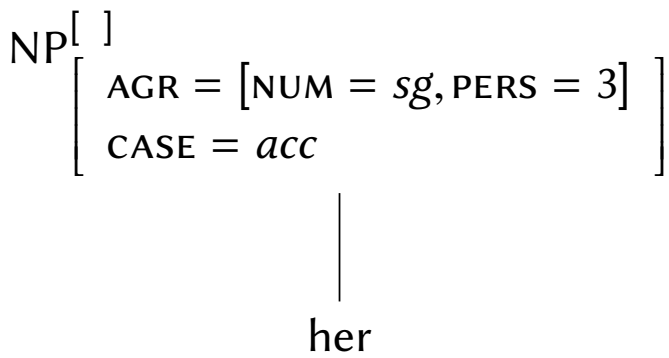

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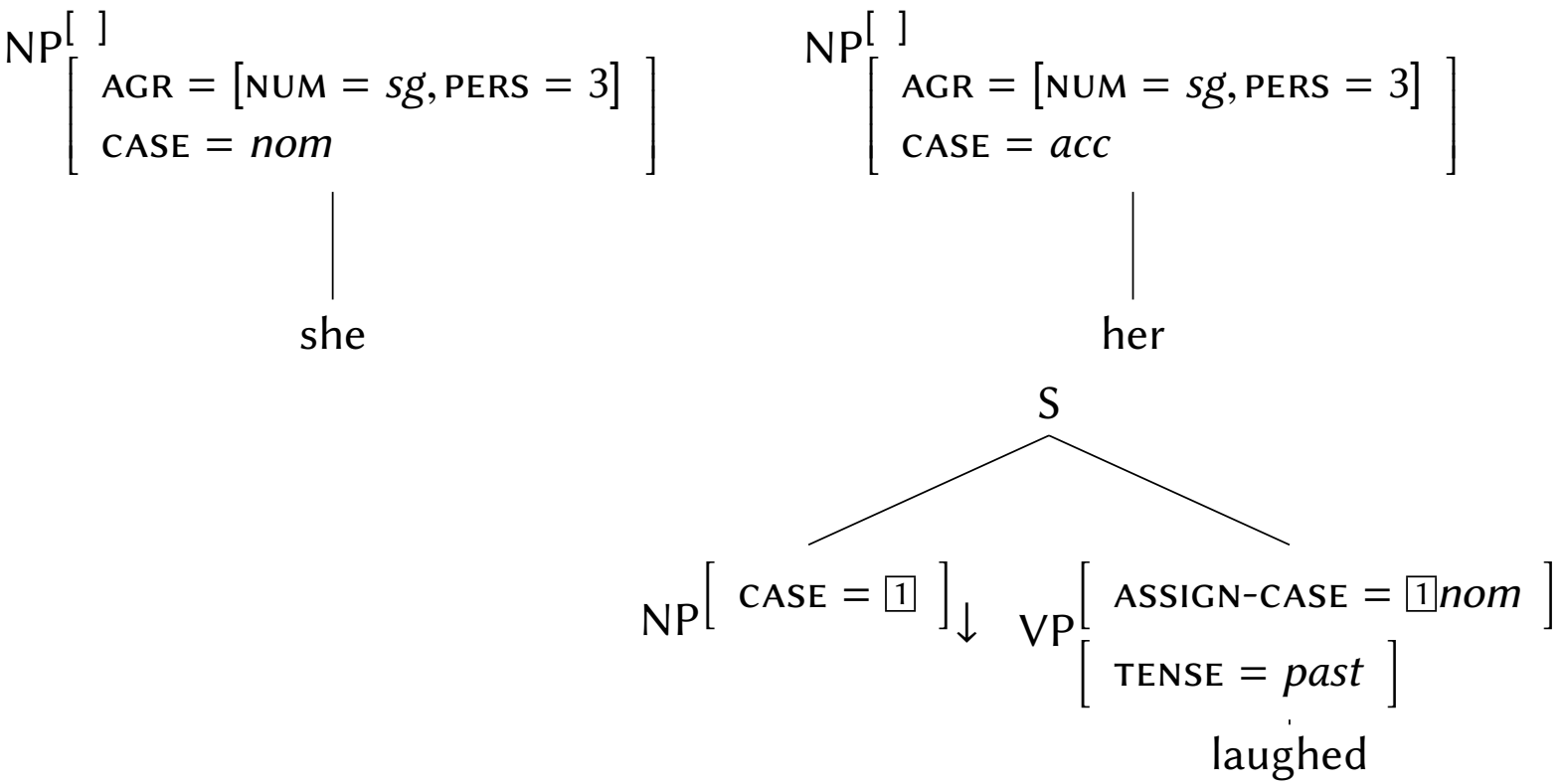

Outline of today's course

1. The derivation tree
2. Design principles for elementary trees
3. Sample derivations
   - NP and PP complements
   - Sentential complements and long-distance dependencies
   - Modifiers
4. Feature based TAG
5. Summary and outlook

Summary & outlook

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- derivation tree vs. derived tree
- design principles: syntactic / semantic / economy
- example derivations: the base cases
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Tomorrow

- further linguistic applications (syntax)
- in particular: extraction and long-distance dependencies
- grammar factorization
- the syntax-semantics interface

References

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