Grammar Implementation with TAG

Natural Language Syntax with TAG

Timm Lichte

HHU Düsseldorf

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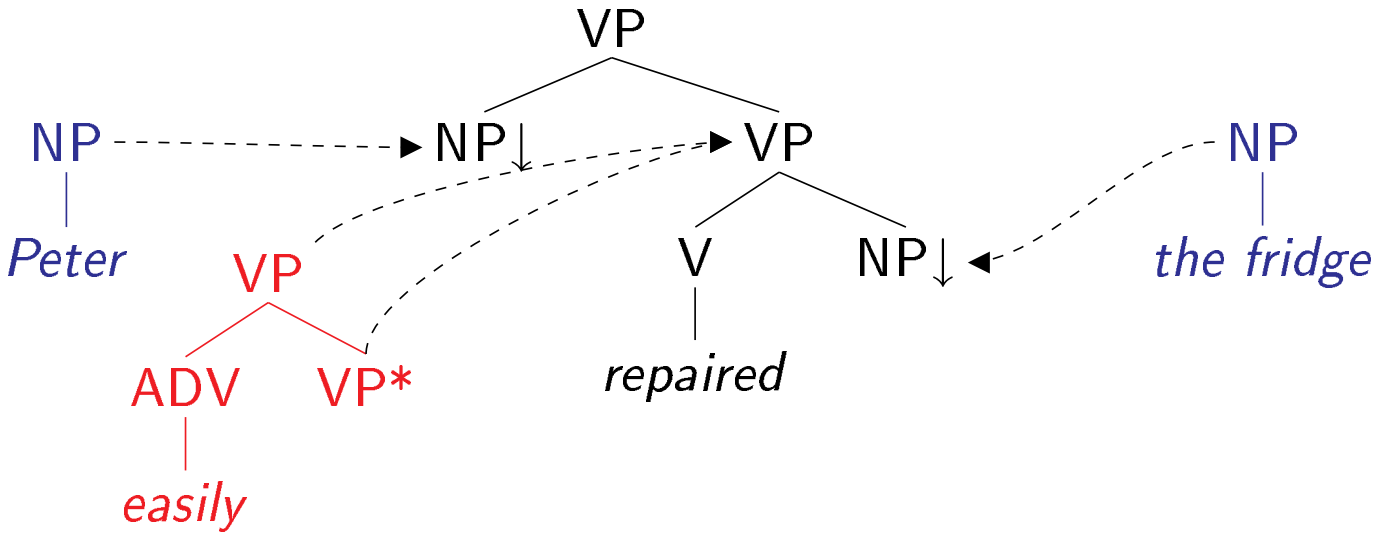
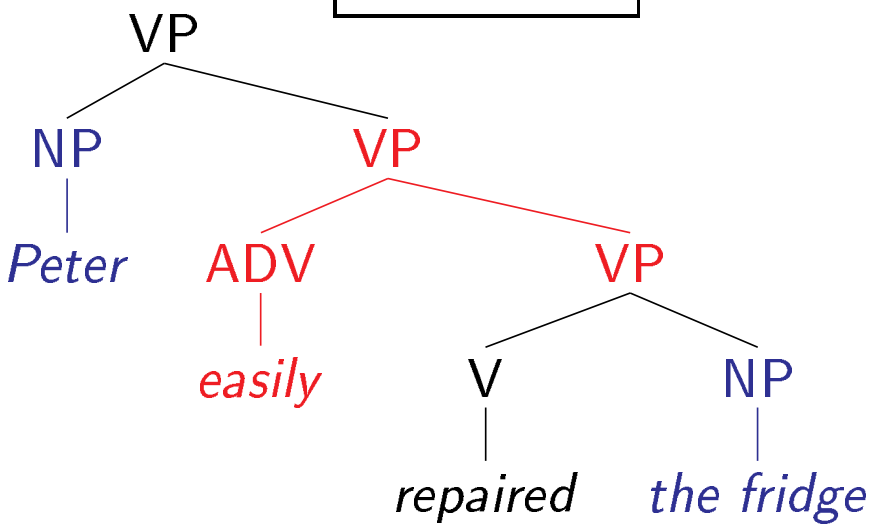
Outline

1. The derivation tree
2. Design principles for elementary trees
3. Sample derivations

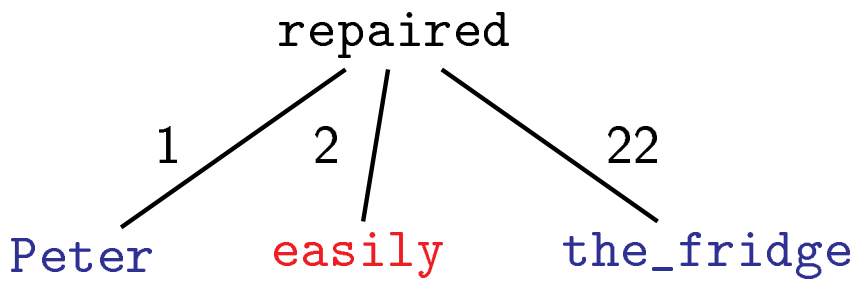
Derivation trees (1): The context



derived tree



derivation tree



Derivation trees (2):

TAG derivations are uniquely described by **derivation trees**.

The derivation tree contains:

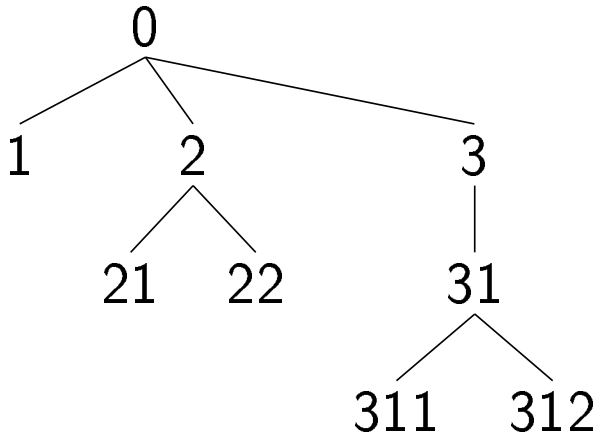
- **nodes** for all elementary trees used in the derivation, and
- **edges** for all adjunctions and substitutions performed throughout the derivation, and
- **edge labels** indicating the target node of the rewriting operation.

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.

Derivation trees (3): Gorn adresses

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

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



Linguistic analyses with LTAG

What is an elementary tree, and what is its shape?

$\Rightarrow$ Design principles for elementary trees from Frank (2002):

- Lexicalization
- Fundamental TAG Hypothesis (FTH)
- Condition on Elementary Tree Minimality (CETM)
- θ-Criterion for TAG

Design principles (1): Lexicalization

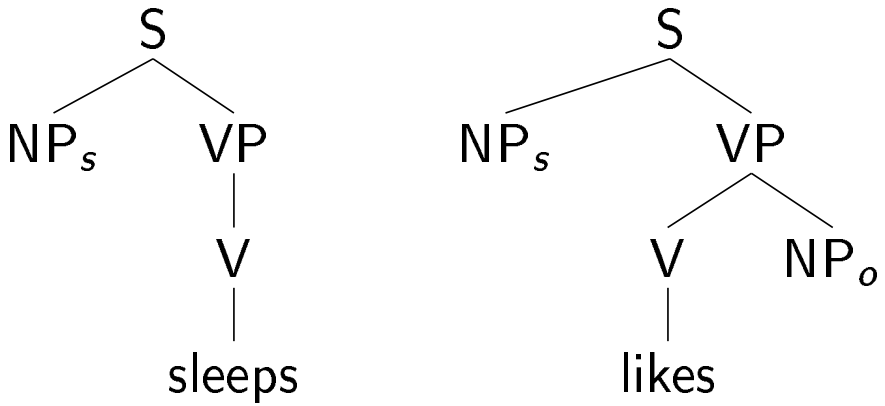
Each elementary tree has at least one non-empty lexical item, its lexical **anchor**.

$\Rightarrow$ All widely used grammar formalisms support some kind of lexicalization!

Reasons for lexicalization:

- The properties of a constituent depend on the lexical items occurring in the constituent: the structure of a VP depends on the subcategorization properties of its verb.

$$VP \rightarrow V_{intrans}$$
$$VP \rightarrow V_{trans}\, NP$$



Design principles (2): Fundamental TAG Hypothesis

Fundamental TAG Hypothesis (FTH)

Every syntactic dependency is expressed locally within an elementary tree. (Frank,2002)

"syntactic dependency"

- valency/subcategorization
- modification
- binding
- dislocations (e.g. extraposition)
- ...

"expressed within an elementary tree"

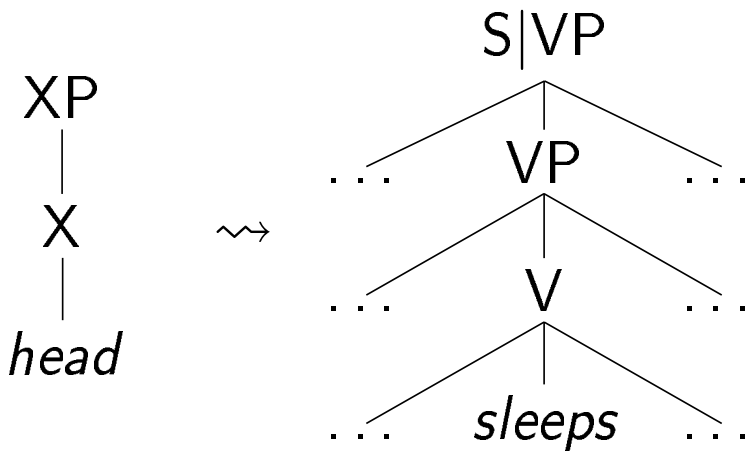
- terminal leaf (i.e. lexical anchor)
- nonterminal leaf (substitution node and footnode)
- marking an inner node for obligatory adjunction

Design principles (3): Cond. on Elementary Tree Minimality

Condition on Elementary Tree Minimality (CETM)

The syntactic heads in an elementary tree and their projections must form the extended projection of a single lexical head. (Frank,2002)

Note: We only use simple, non-extended projections!



Design principles (4): θ-Criterion for TAG

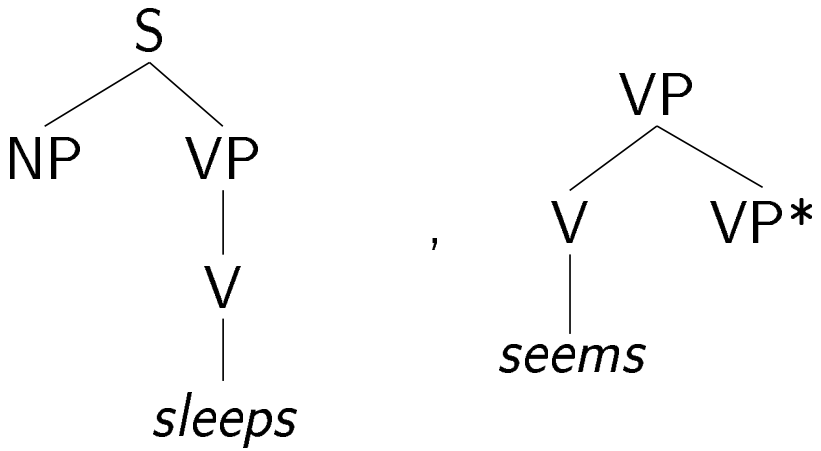
θ-Criterion (TAG version)

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

b. If A is a frontier non-terminal of elementary tree T, A must be assigned a θ-role in T.

(Frank,2002)

$\Longrightarrow$ Valency/subcategorization is expressed only with nonterminal leaves!



Blind spot: Modification and functional elements

How to insert **modifiers** (*easily*) and **funtional elements** (complementizers, determiners, do-auxiliaries, ...)?

- Either by separate auxiliary trees (e.g., XTAG grammar),
- or as co-anchor in the elementary tree of the lexical item they are associated with.

Modifiers are generally represented by auxiliary trees.

$\Rightarrow$ Footnodes/Adjunctions indicate both complementation and modification.

$\Rightarrow$ Enhancement of the CETM: core tree (following CETM) + spine

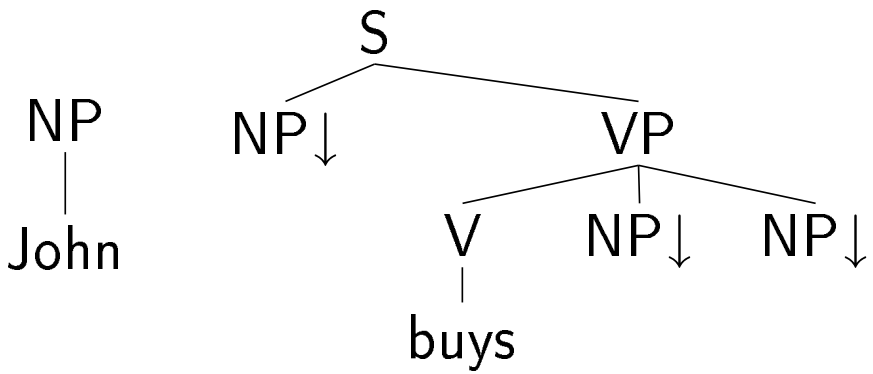
Sample derivations

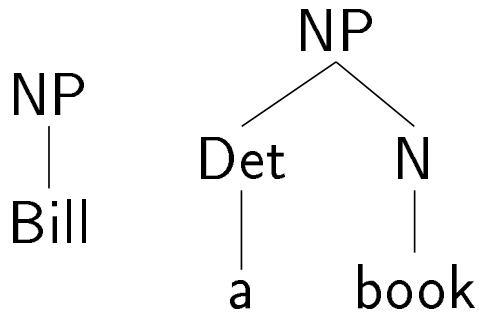
- Complementation with: NPs, PPs, adjectives, clauses (raising, controlling), ...
- Modification with: PPs, adjectives, particles, temporal clauses, relative clauses, ...

Sample derivations: NP complements

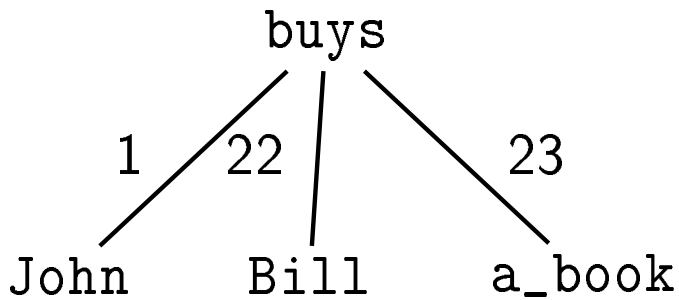
(1) John buys Bill a book

Elementary trees:





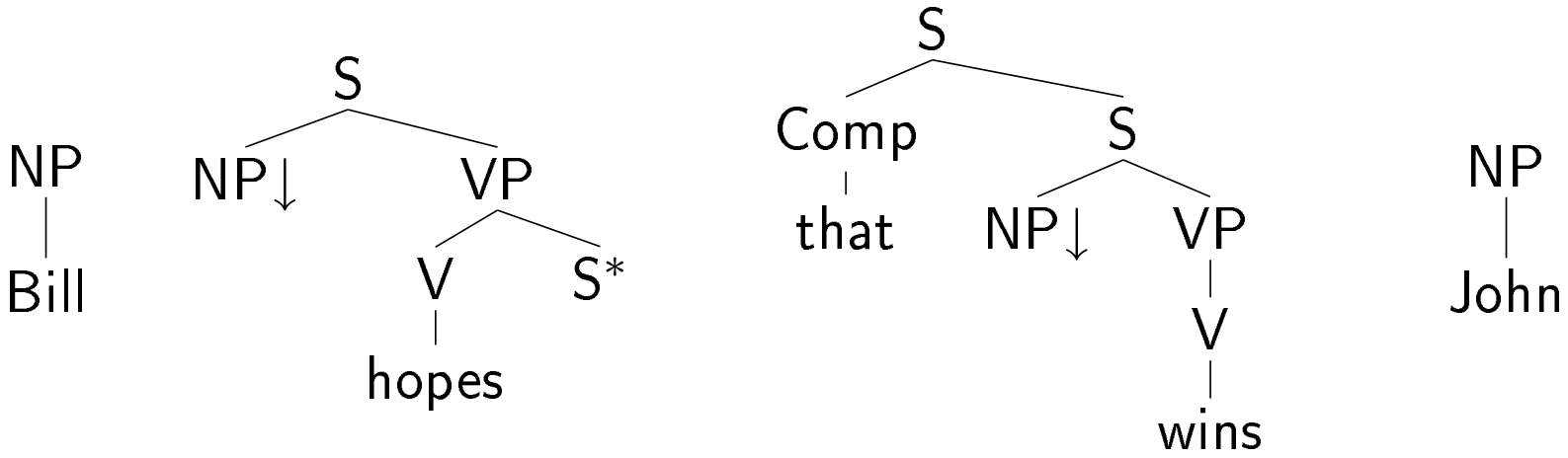
Derivation tree:



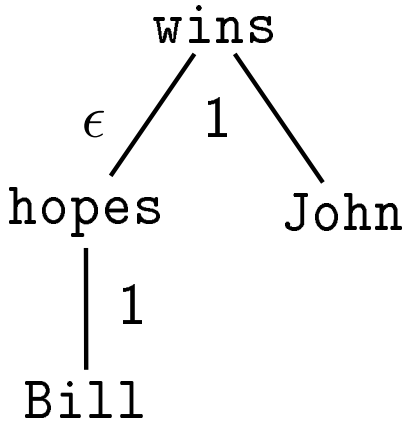
Sample derivations: Sentential complements (1)

(2) Bill hopes that John wins

Elementary trees:



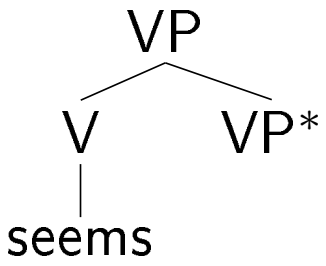
Derivation tree:

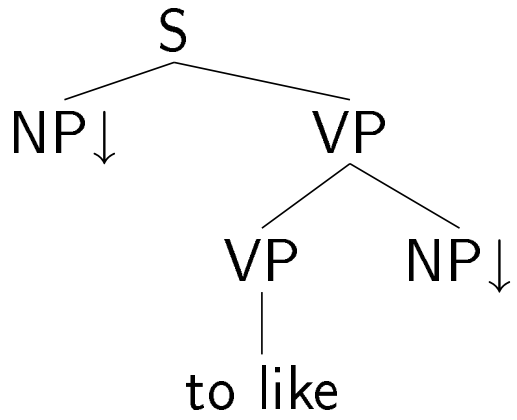


Sample derivations: Sentential complements (2)

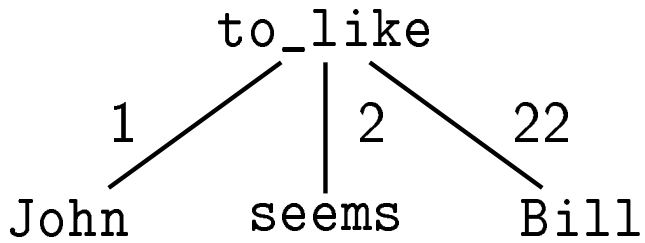
(3) John seems to like Bill

Elementary trees:





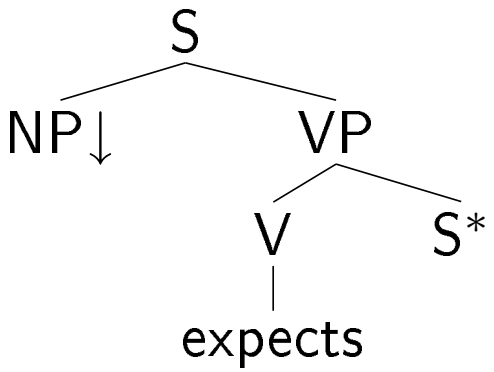
Derivation tree:

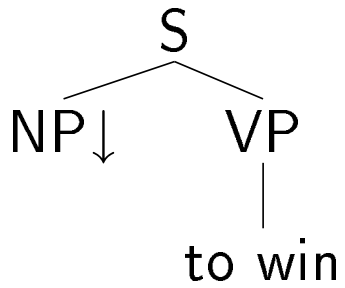


Sample derivations: Sentential complements (3)

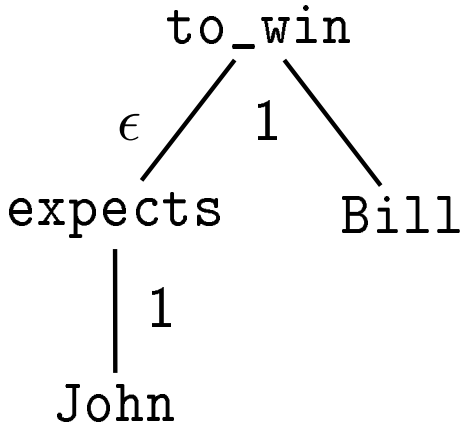
(4) John expects [Bill to win]

Elementary trees:





Derivation tree:



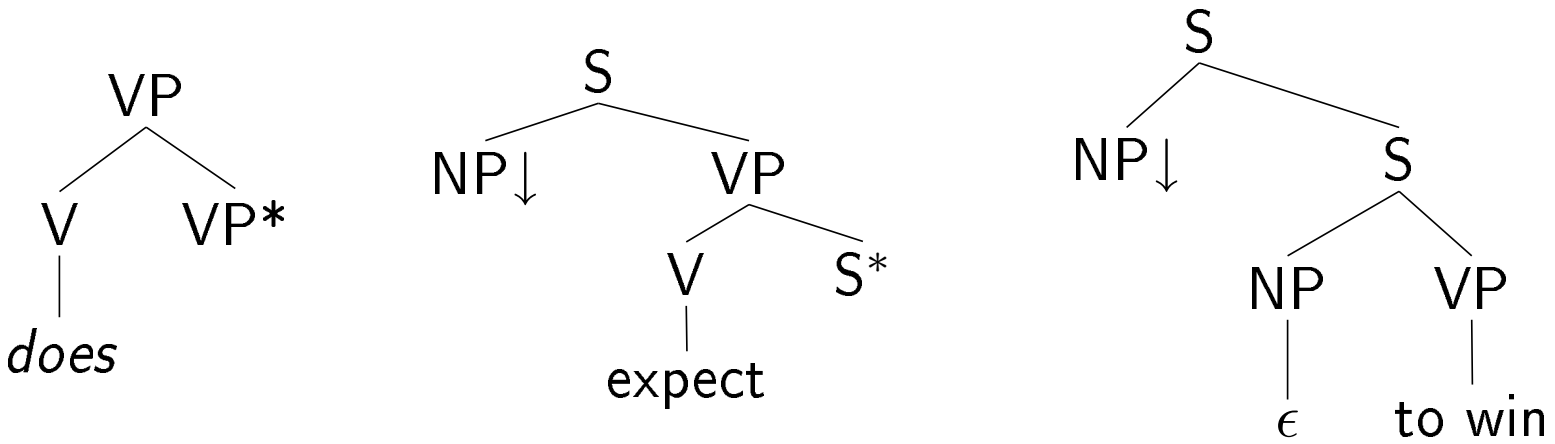
Sample derivations: Sentential complements (4)

Question: Why is the sentential object represented as a footnode?

The sentential object is realised as a foot node in order to allow extractions:

(5) Who does John expect to win?

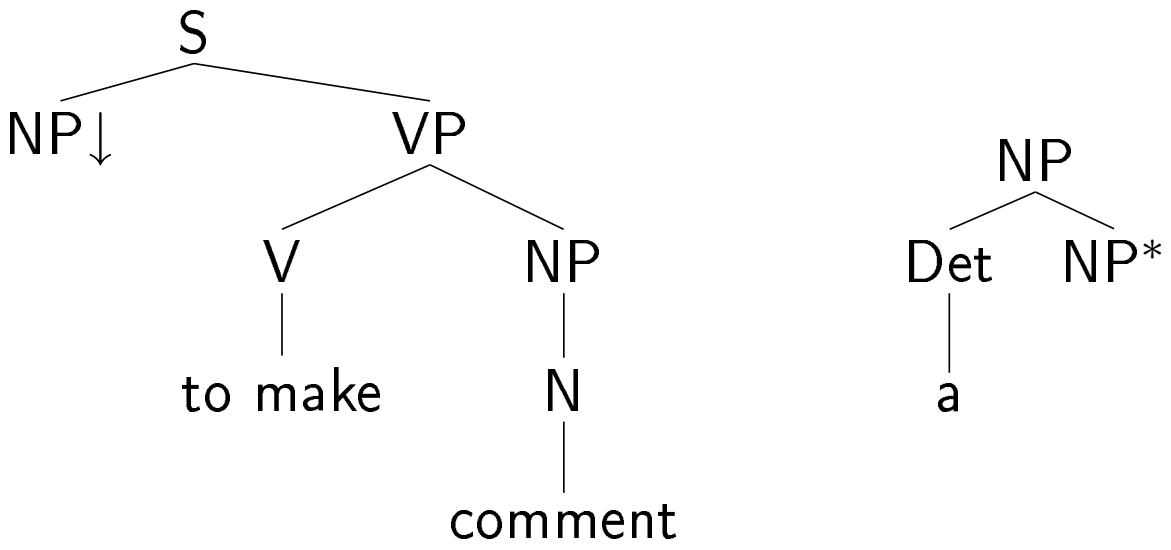
Elementary trees:



Sample derivations: Multiple anchors

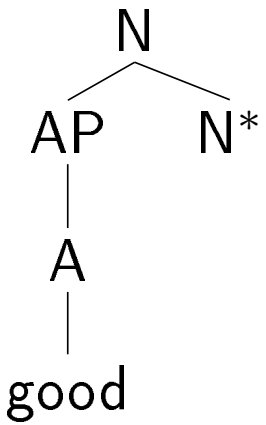
Multiword expressions and light verb constructions can be represented by elementary trees with multiple anchors:

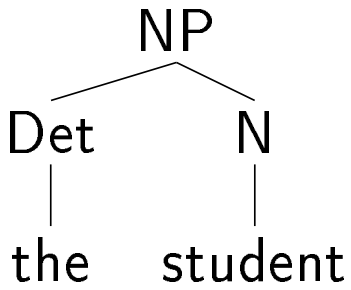
(6) John expected [Mary to make a comment]

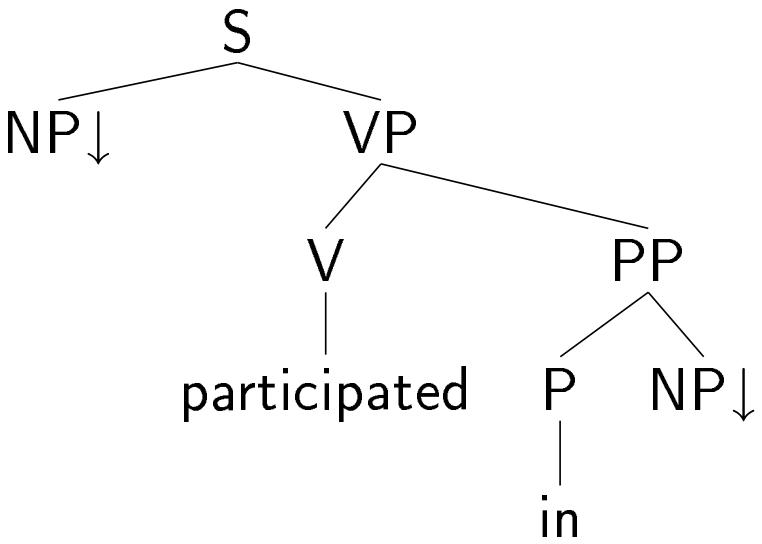


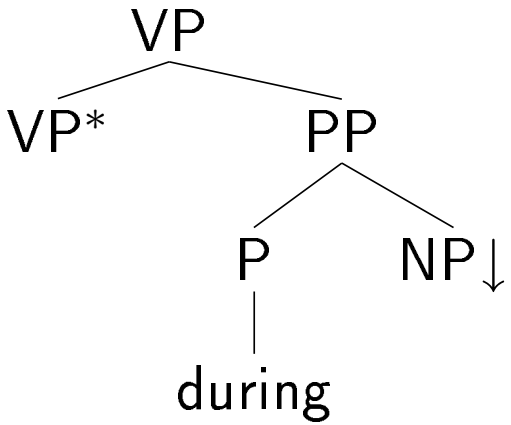
Sample derivations: Modifiers

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



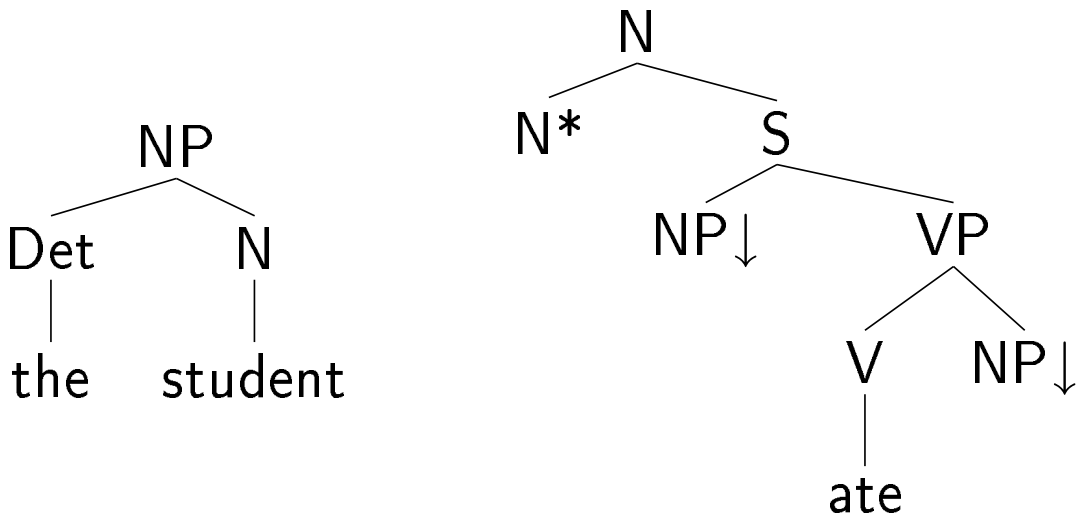






Sample derivations: Relative clauses

(8) the dog [who ate the cake]



Problem: Extraposed relative clauses:

(9) Somebody$_i$ lives nearby [who$_i$ has a CD-burner].

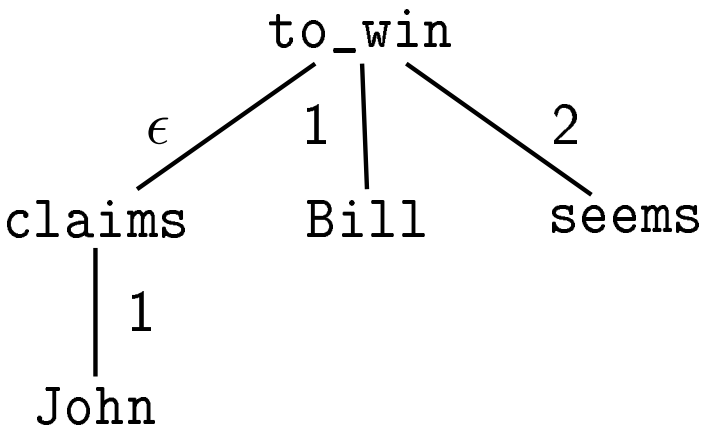
Derivation trees = Semantic dependency structure ?

The derivation tree is not always the semantic dependency structure, due to:

- indiscernibility of complementation and modification in adjunction, and
- missing links.

Example for a missing link:

(10) John claims Bill seems to win



Summary

- TAG derivations are described by derivation trees.
- In LTAG, elementary trees for lexical predicates contain slots for all arguments of these predicates, for nothing else. Recursion is factored away.
- The derived tree describes the constituent structure while the derivation tree is close to a semantic dependency graph.