

Tree Adjoining Grammars

Syntax in LTAG

Laura Kallmeyer & Benjamin Burkhardt

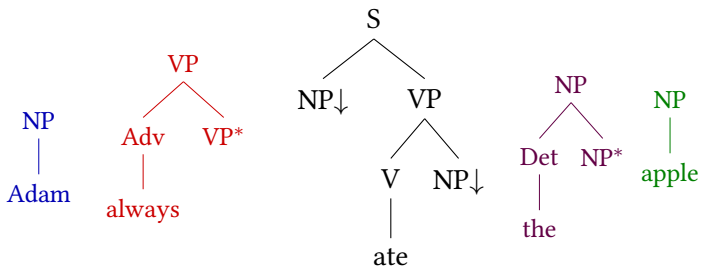
HHU Düsseldorf

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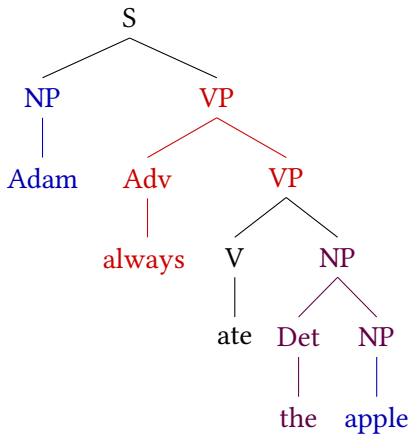
Outline

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

Derivation trees: Example derivation



Derivation trees: Example derivation



Derivation trees

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 .

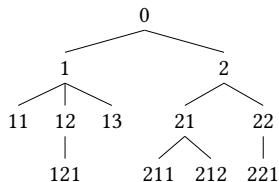
Note that derivation trees are unordered trees.

Adjunction edges are sometimes depicted as dashed lines, substitution edges as solid lines.

Derivation trees

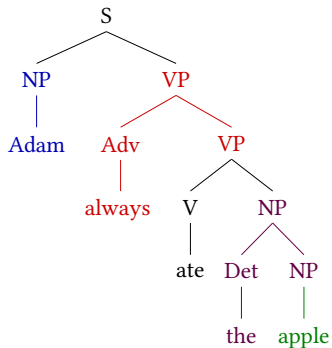
For the node addresses of elementary trees, **Gorn addresses** are used:

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

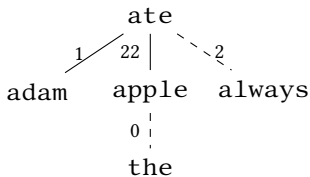


Derivation trees: example

Derived tree:

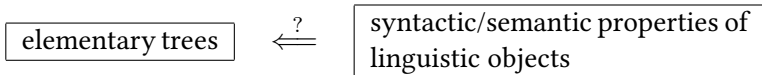


Derivation tree:



Linguistic analyses with LTAG

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



⇒ Syntactic design principles from [Frank \(2002\)](#):

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

⇒ Semantic design principles [[Abeillé & Rambow \(2000\)](#)]

⇒ Design principle of economy

Further overviews are given in chapter 5 of [Lichte \(2015\)](#) (in German) and chapter 4 of [Kallmeyer \(2010\)](#).

Syntactic design principles (1): Lexicalization

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

⇒ All widely used grammar formalisms support some kind of lexicalization!

⇒ TAG → LTAG: Lexicalized Tree-Adjoining Grammar

[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).

Syntactic design principles (2): FTH

Fundamental TAG Hypothesis (FTH); [Frank (2002)]

Every syntactic dependency is expressed locally within an elementary tree.

“syntactic dependency”

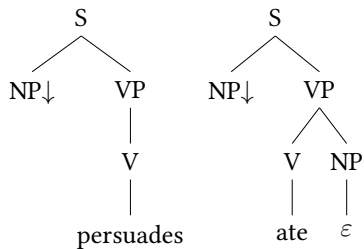
- valency/subcategorization
- binding
- filler-gap constructions
- ...

“expressed within an elementary tree”

- terminal leaf (i.e. lexical anchor)
- nonterminal leaf (substitution node and footnote)
- 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.”

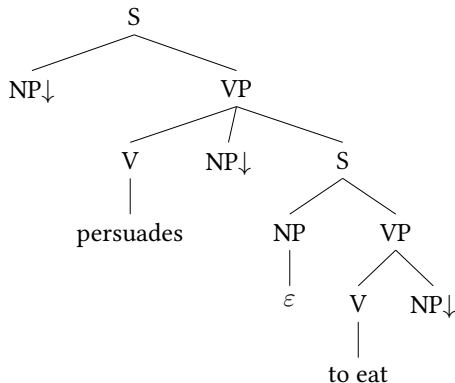
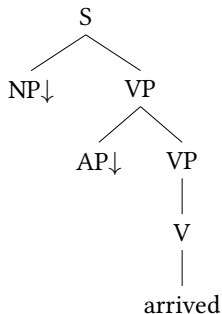
[Joshi (2004)]

Syntactic design principles (3): CETM

Condition on Elementary Tree Minimality (CETM); ; [Frank (2002)]

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

Examples of ill-formed elementary trees:



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.

- example: *Bart kicked the ball.*
 - *kicked* \rightsquigarrow predicate
 - *Bart* \rightsquigarrow AGENT
 - *ball* \rightsquigarrow THEME/PATIENT
- *The ball was kicked by Bart.*
 - *kicked* \rightsquigarrow predicate
 - *Bart* \rightsquigarrow AGENT
 - *ball* \rightsquigarrow THEME/PATIENT

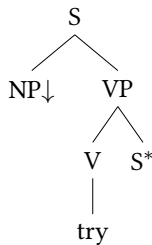
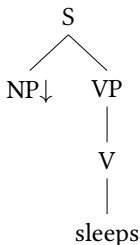
Syntactic design principles (4): θ -Criterion for TAG

θ -Criterion (TAG version)

- If H is the lexical head of an elementary tree T, H assigns all of its θ -roles in T.
- If A is a frontier non-terminal of elementary tree T, A must be assigned a θ -role in T.

[Frank (2002)]

\implies Valency/subcategorization is expressed only with nonterminal leaves!



Further design principles

Semantic design principles

Predicate-argument co-occurrence:

Each elementary tree associated with a predicate contains a non-terminal leaf for each of its arguments.

Semantic anchoring:

Elementary trees are not semantically void (to, that.)

Compositional principle:

An elementary tree corresponds to a single semantic unit.

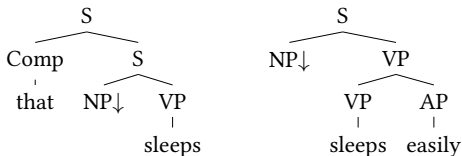
Design principle of economy

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

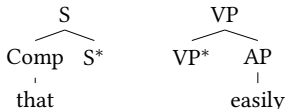
Modification and functional elements

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

- either as co-anchor in the elementary tree of the lexical item they are associated with



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



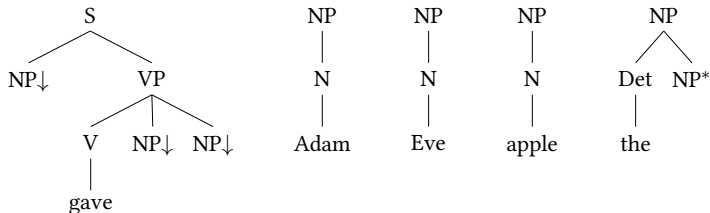
⇒ Footnodes/Adjunctions indicate both complementation and modification.

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

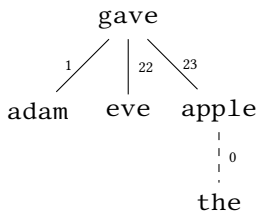
Sample derivations: NP and PP complements

(1) Adam gave Eve the apple.

Elementary trees:



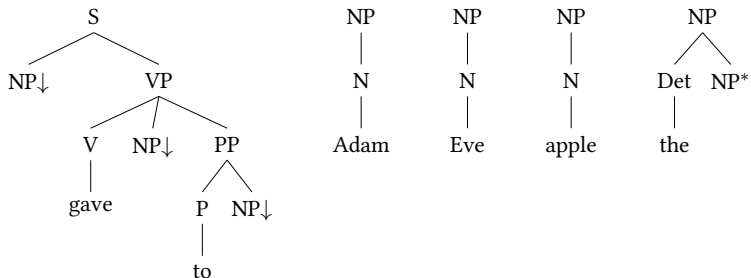
Derivation tree:



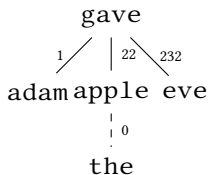
Sample derivations: NP and PP complements

(2) Adam gave the apple to Eve.

Elementary trees:



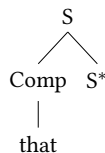
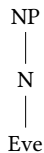
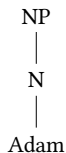
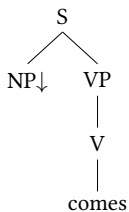
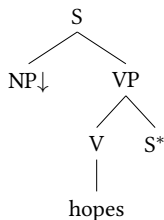
Derivation tree:



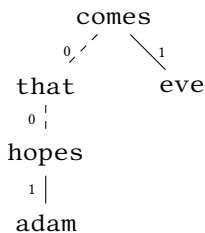
Sample derivations: Sentential complements

(3) Adam hopes that Eve comes.

Elementary trees:

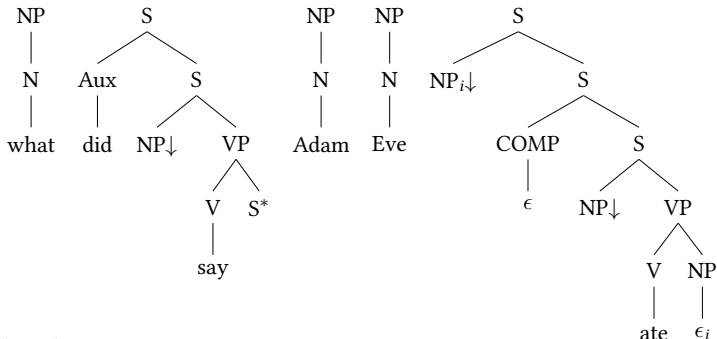


Derivation tree:

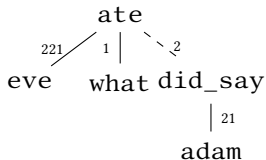


Sample derivations: long-distance dependency

(4) What_i did Adam say (that) Eve ate __i?



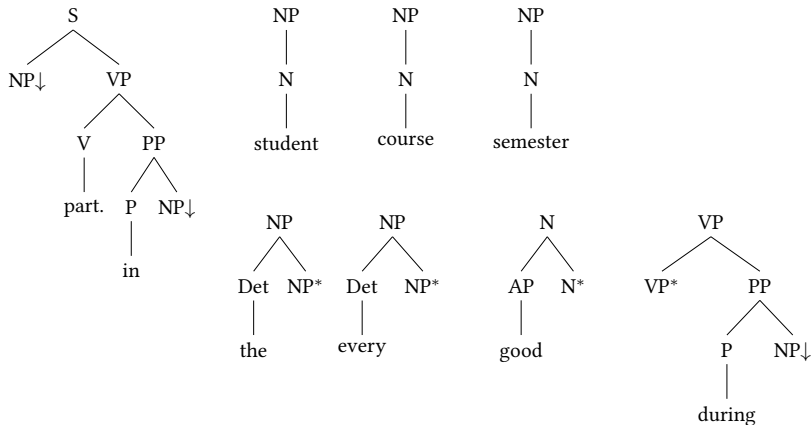
Derivation tree:



Sample derivations: Modifiers

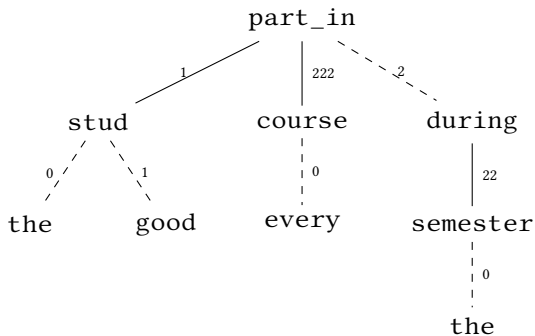
(5) The good student participated in every course during the semester.

Elementary trees:



Sample derivations: Modifiers

Derivation tree:



References

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