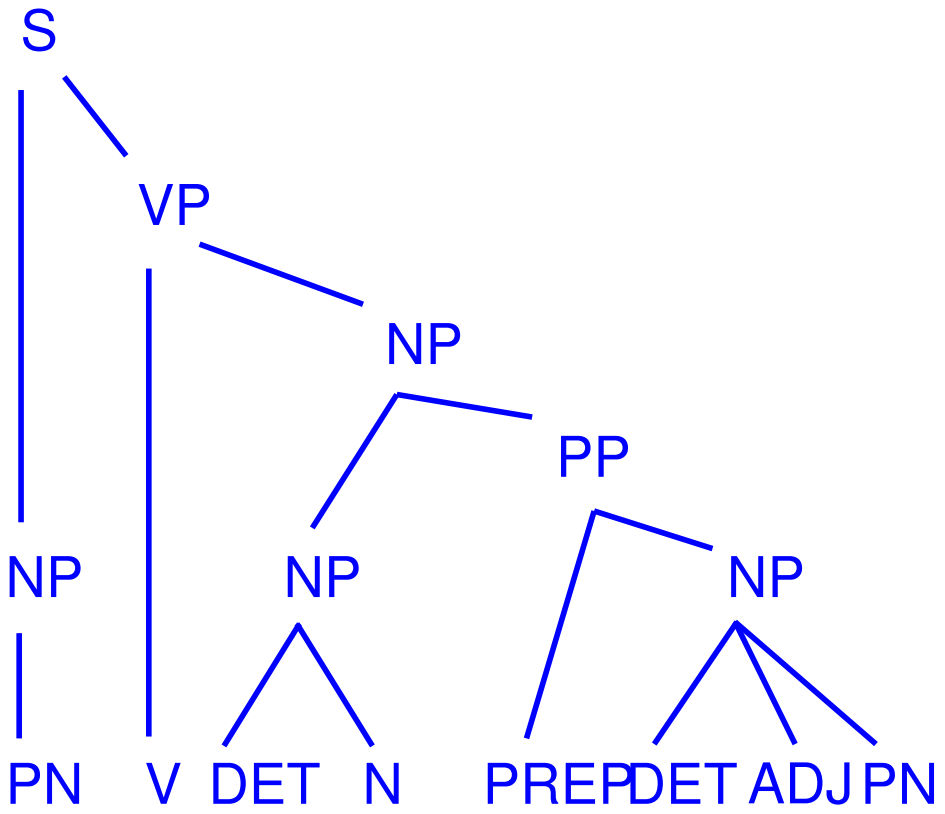
Dependency Parsing

Fabian M. Suchanek

Grammars help with structure



S -> NP VP

NP -> N

VP -> V

NP -> DET ADJ N

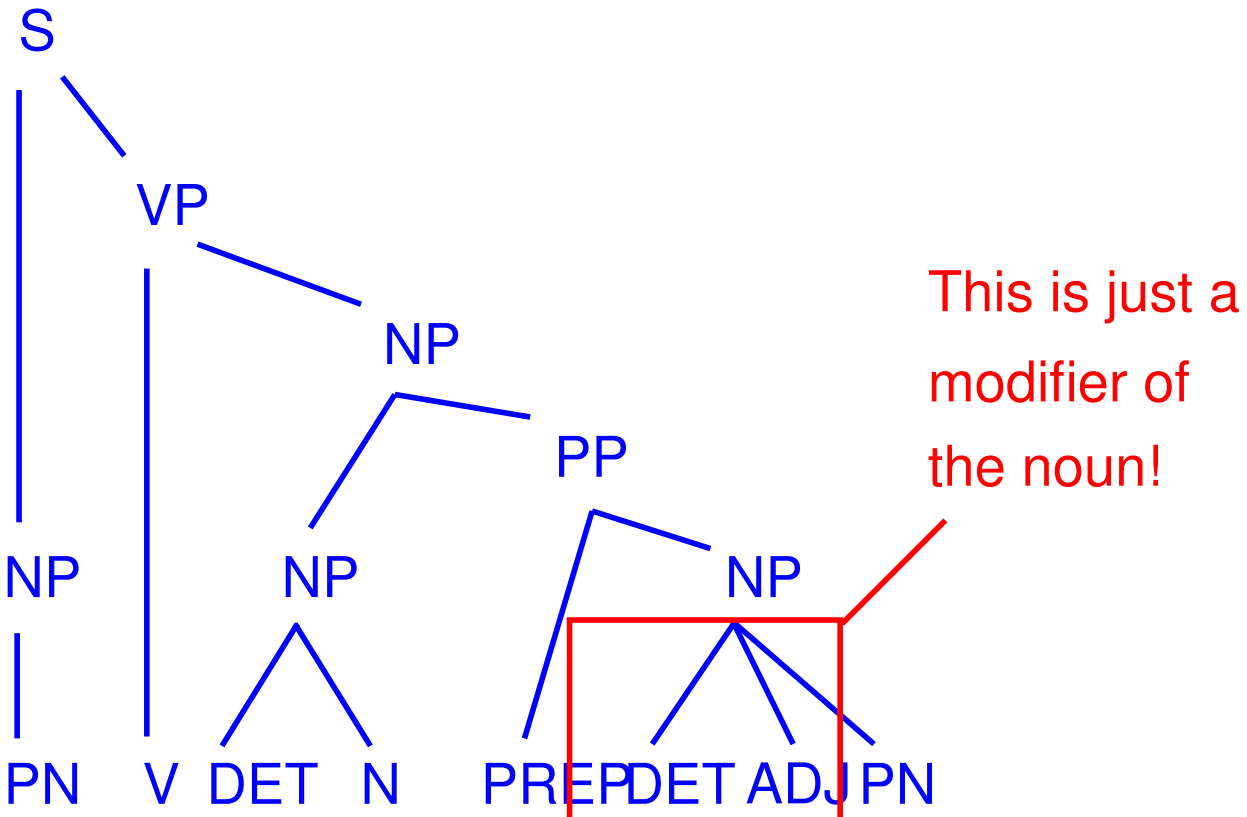
see Wikipedia/Phrase Structure Grammar

try it out

Alizée is the mother of the little Annily.

"X is the mother of Y"

Grammars help with structure



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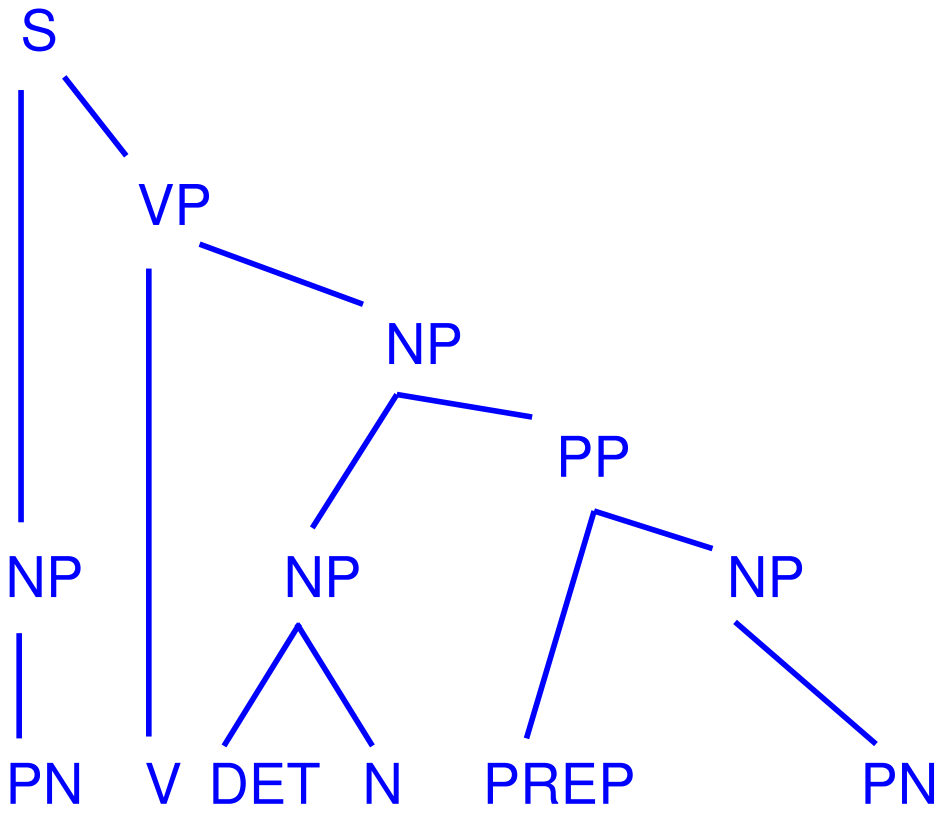
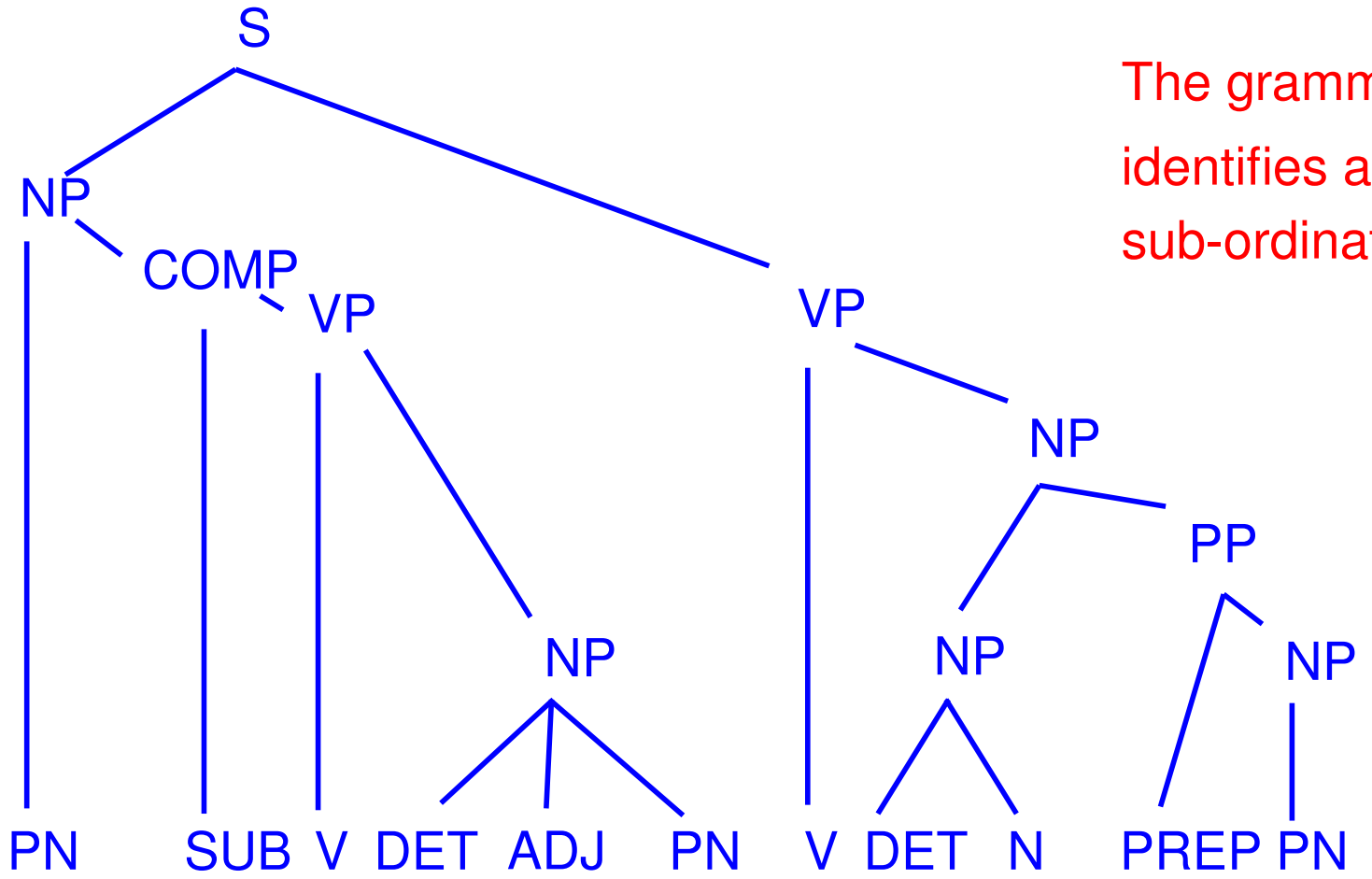


If we remove the modifiers, we match the pattern.

Alizée is the mother of th ıily.

"X is the mother of Y"

Grammars help with structure

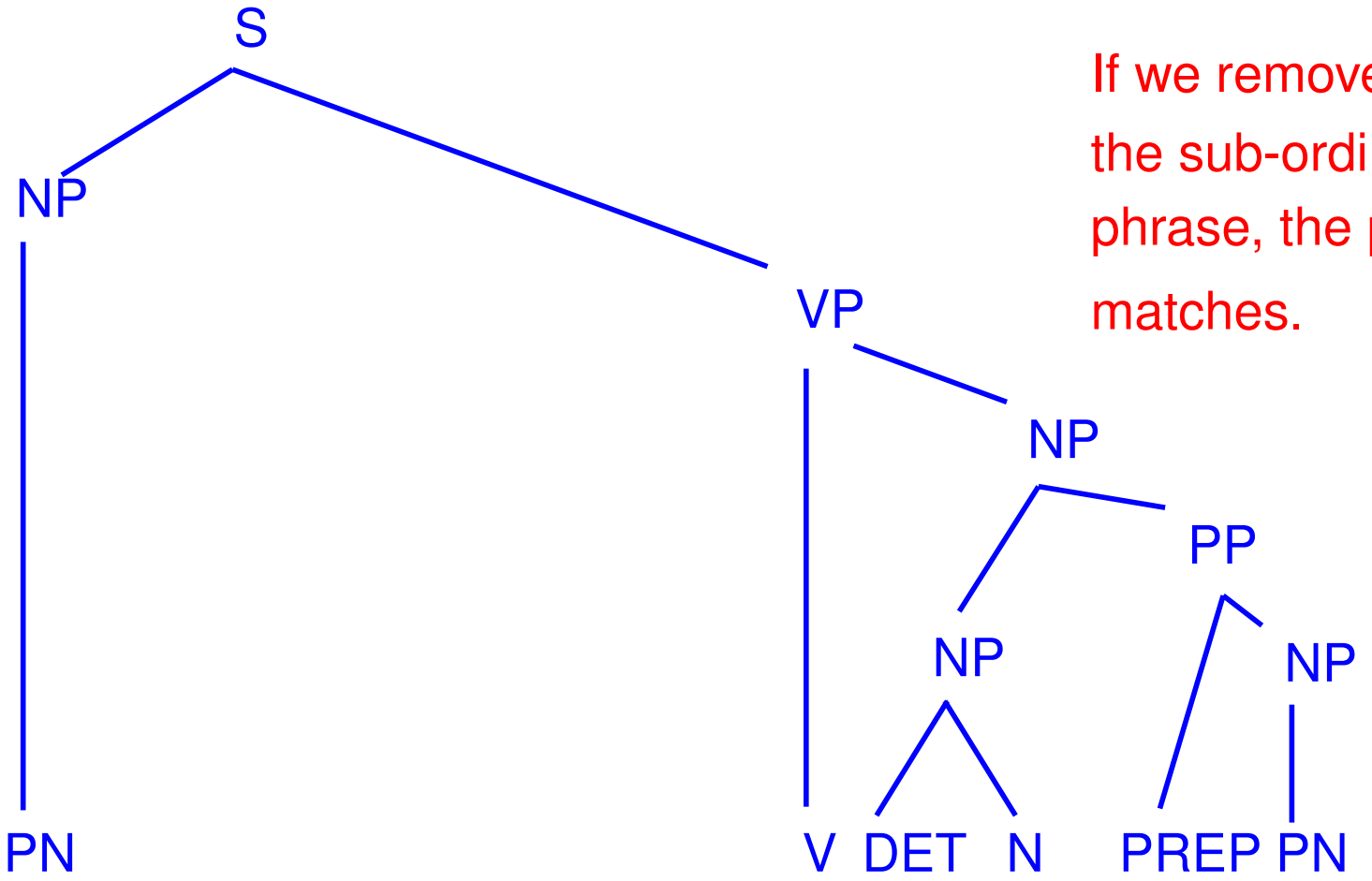


The grammar identifies a sub-ordinate phrase.

Alizée, who has a beautiful voice, is the mother of Annily.

"X is the mother of Y"

Grammars help with structure



If we remove the sub-ordinate phrase, the pattern matches.

Alizée,

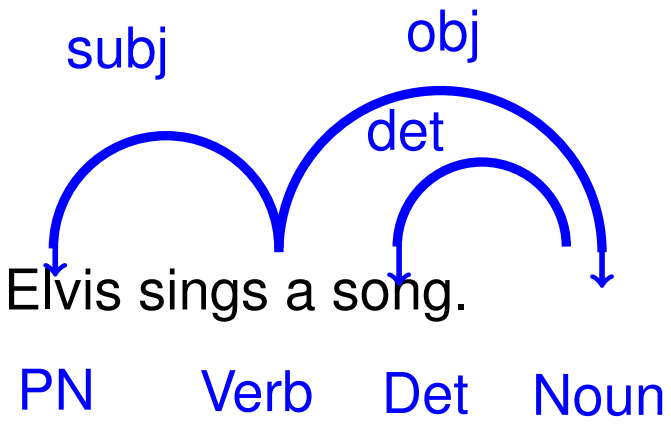
the mother of Annily.

"X

is the mother of Y"

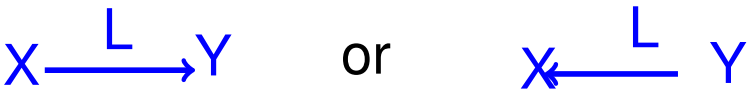
Dependency grammars

In IE, one often uses dependency grammars.



Def: Dependency grammar

A dependency grammar is a set of rules of the form

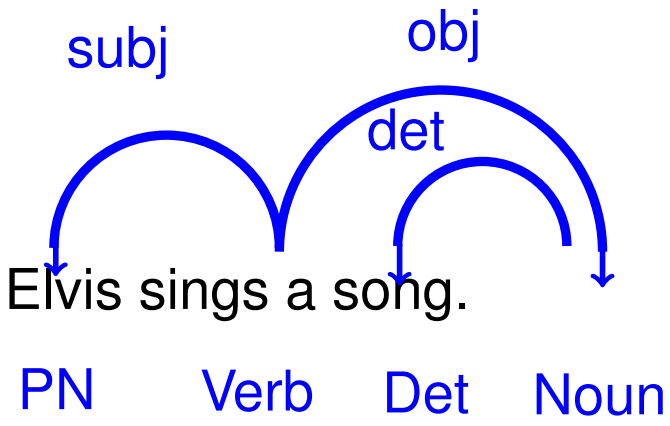


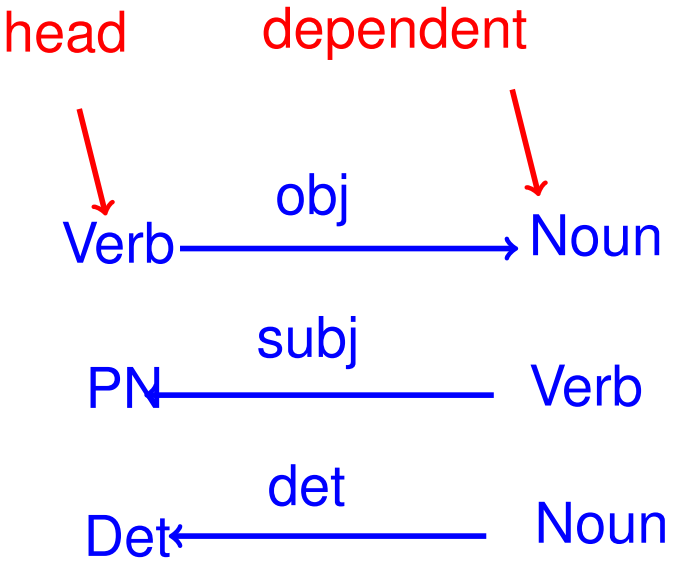
where X and Y are POS tags, L is a label.

(There are variants, where X and Y are words, or rules have more edges or no label)

(Dependency grammars and constituency grammars are strongly equivalent, as shown by H. Gaifman in 1965)

Joakim Nivre

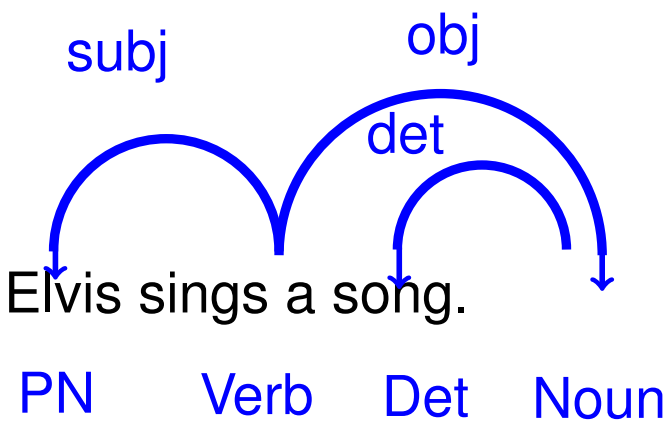


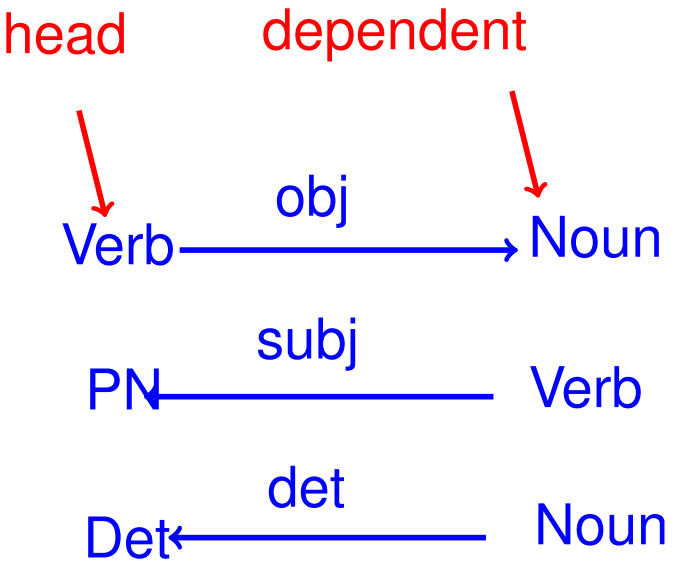


Dependency graph

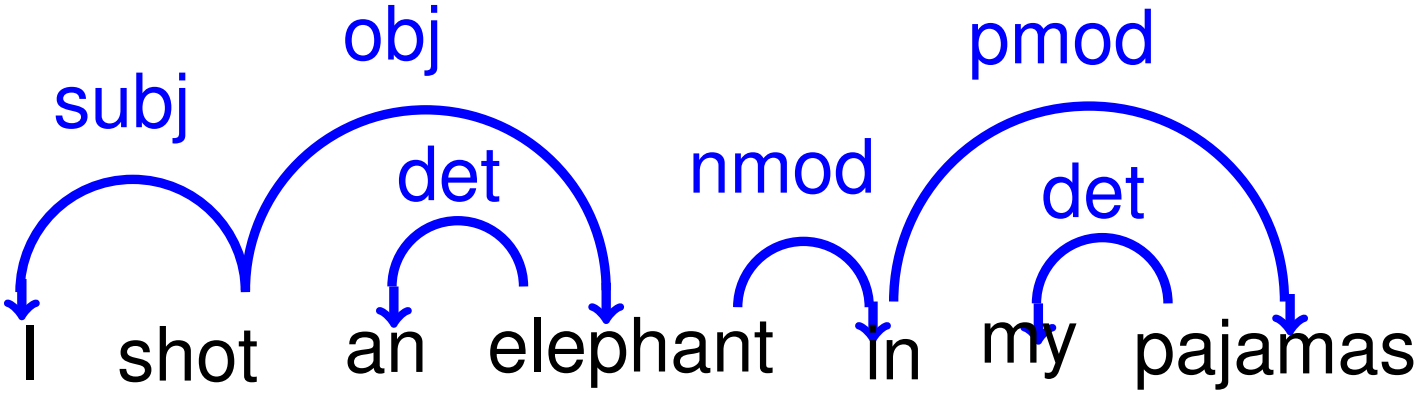
A dependency graph of a sentence is a connected acyclic graph whose nodes are the words and whose edges are given by the grammar, such that

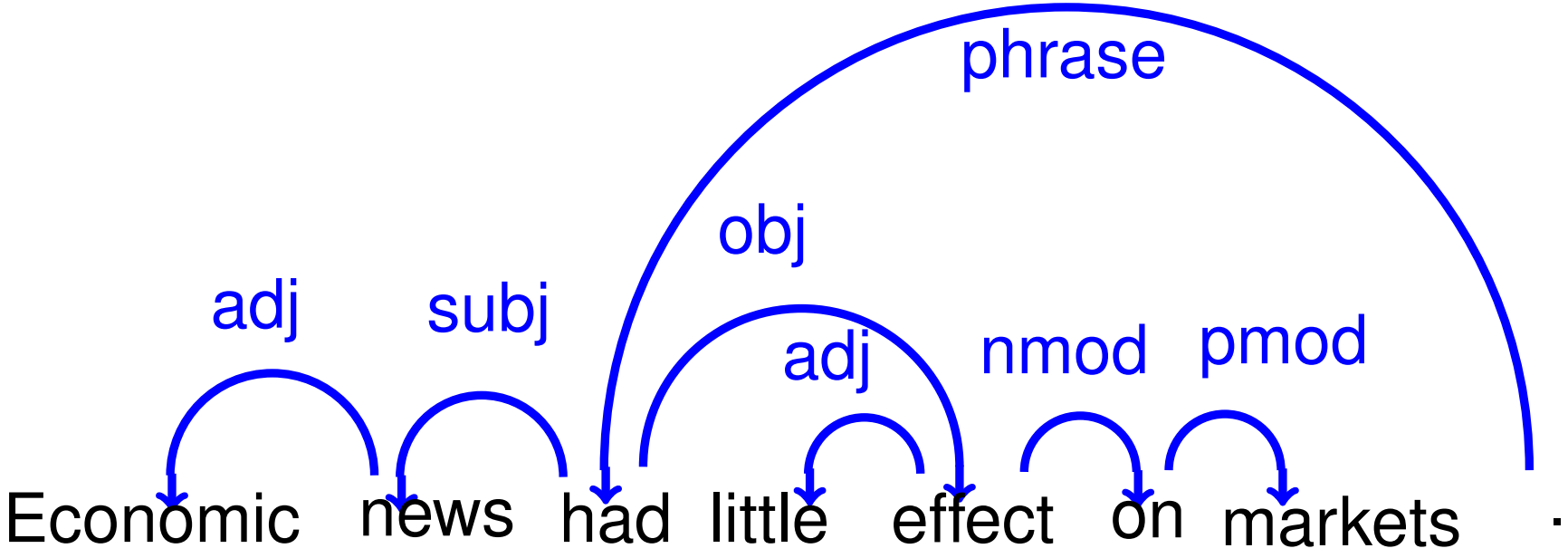
- Every word has at most one head
- There is a verb without a head





Examples: Dependency graph

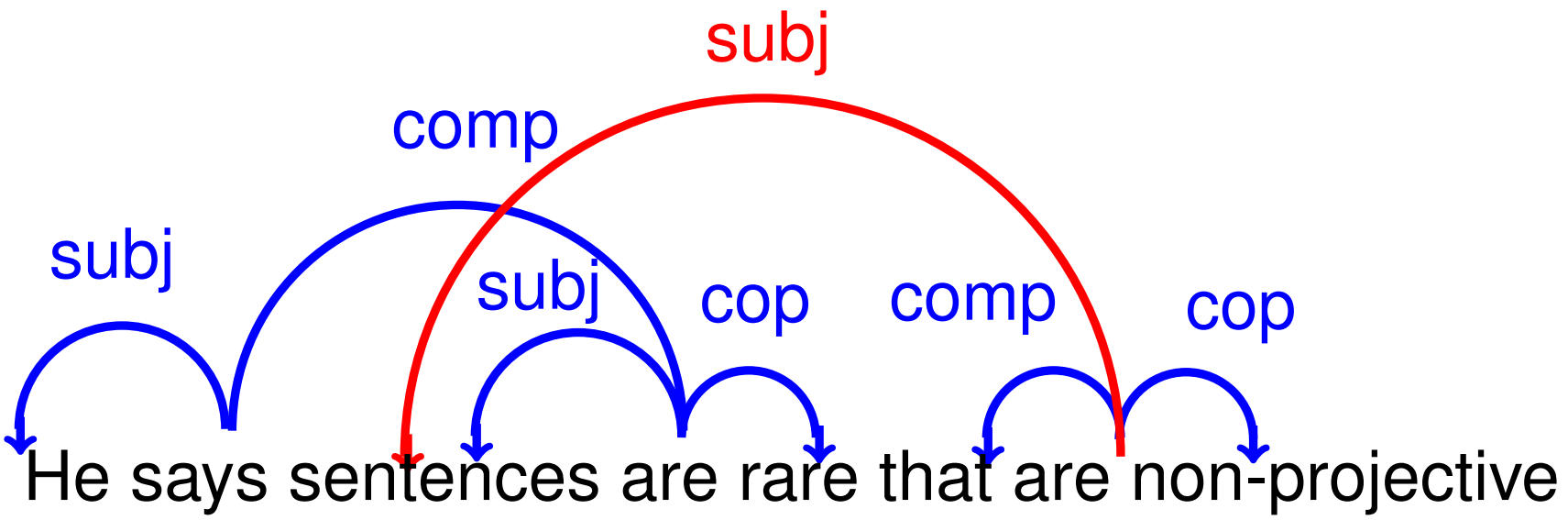




Try it out!

Projection

A dependency graph is projective if no arcs cross.

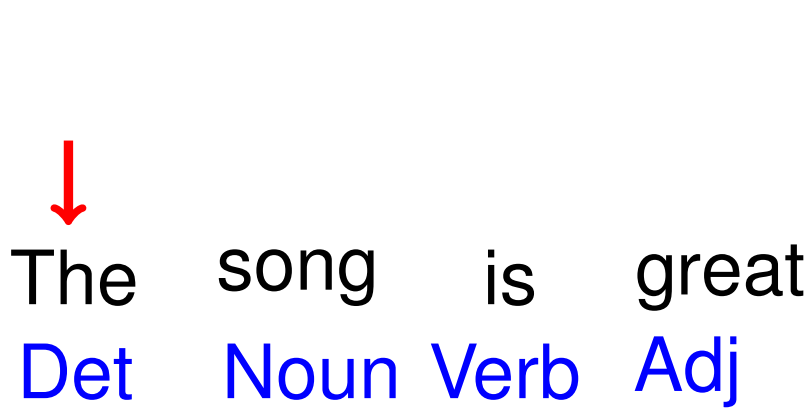


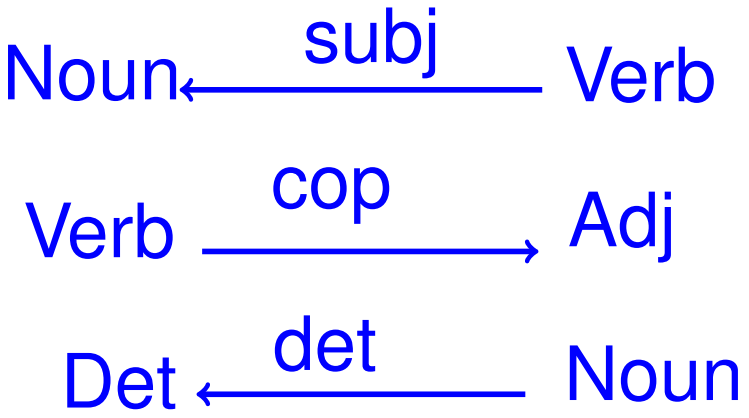
We consider only projective dependency graphs here.

convington>98

Convington's Algorithm

- Parse the sentence left to right
  - Try to link every word to every previous word as permitted by the grammar, going backwards in the sentence, allowing only one head per word.





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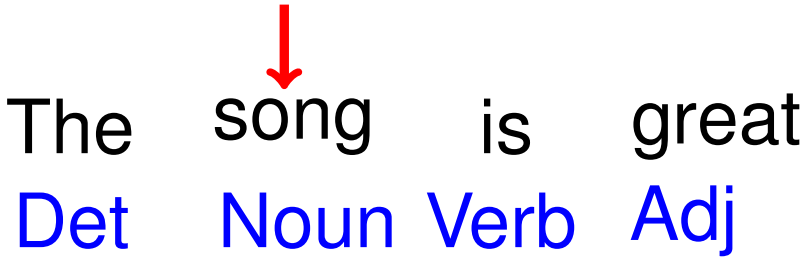

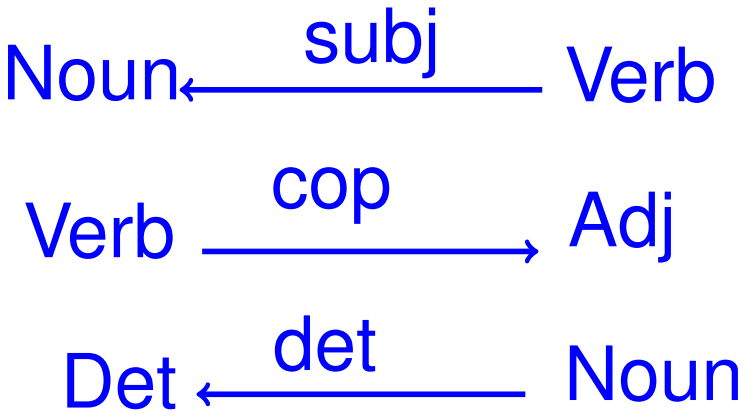

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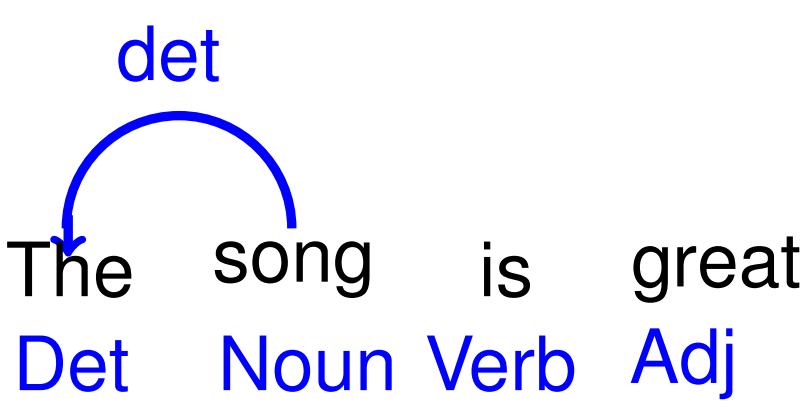

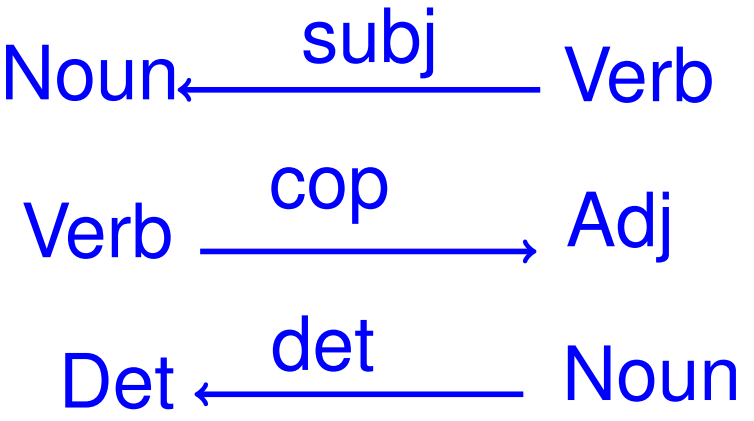

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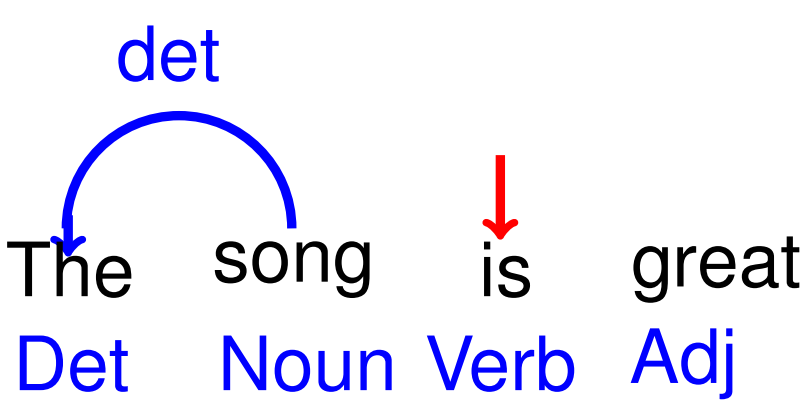

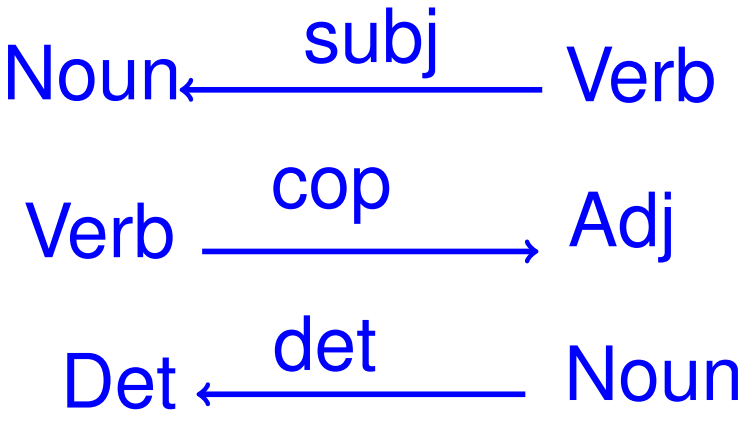

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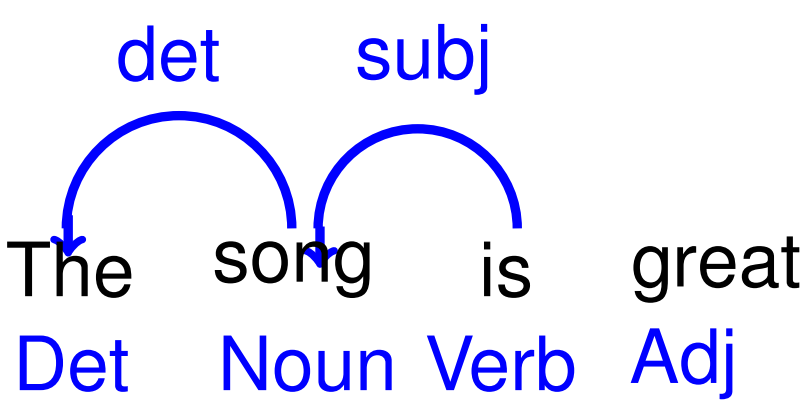

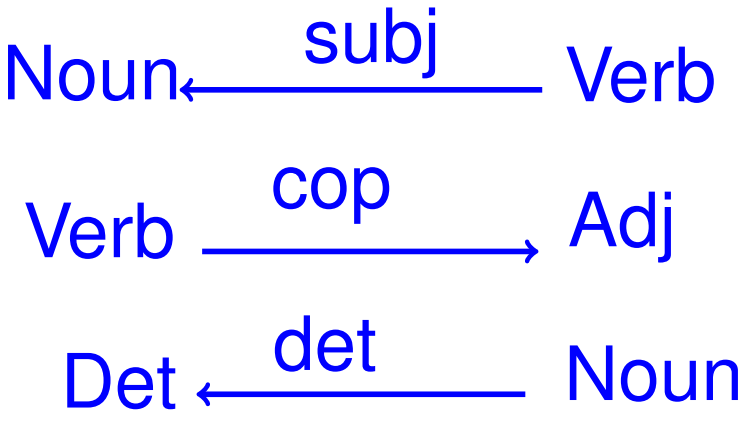

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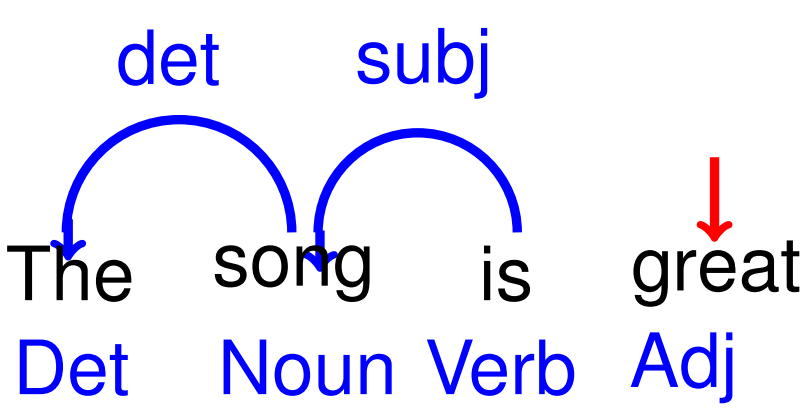

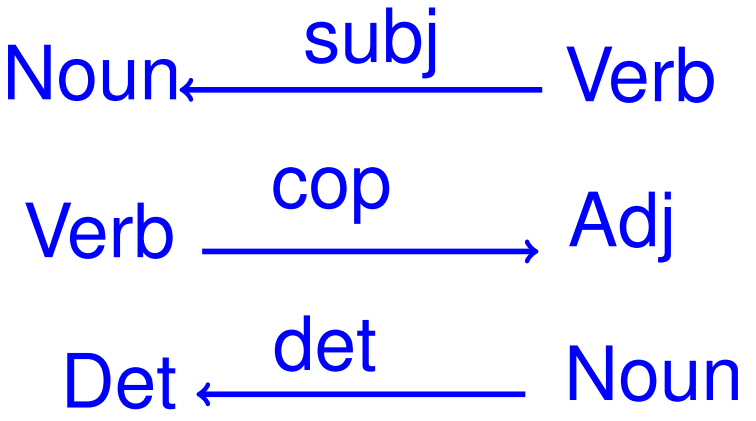

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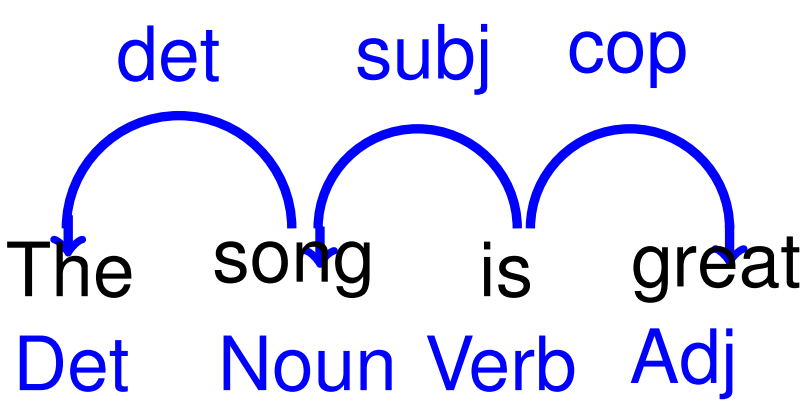

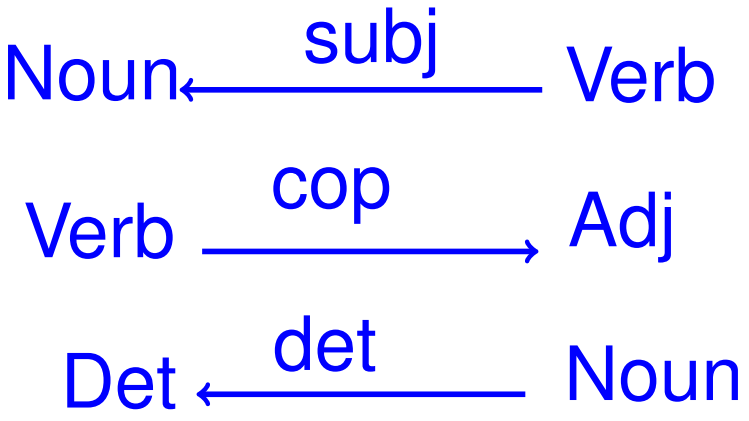

Task: Convington's Algorithm

Apply Convington's algorithm to

Not every idea by Coyote was brilliant.

NEG DET N PREPPN V ADJ

N —prep→ PREP

PREP —pobj→ PN

N ←subj— V

V —cop→ ADJ

DET ←det— N

NEG ←neg— N

Runtime of Convington's Algorithm

Not every idea by Coyote was brilliant.

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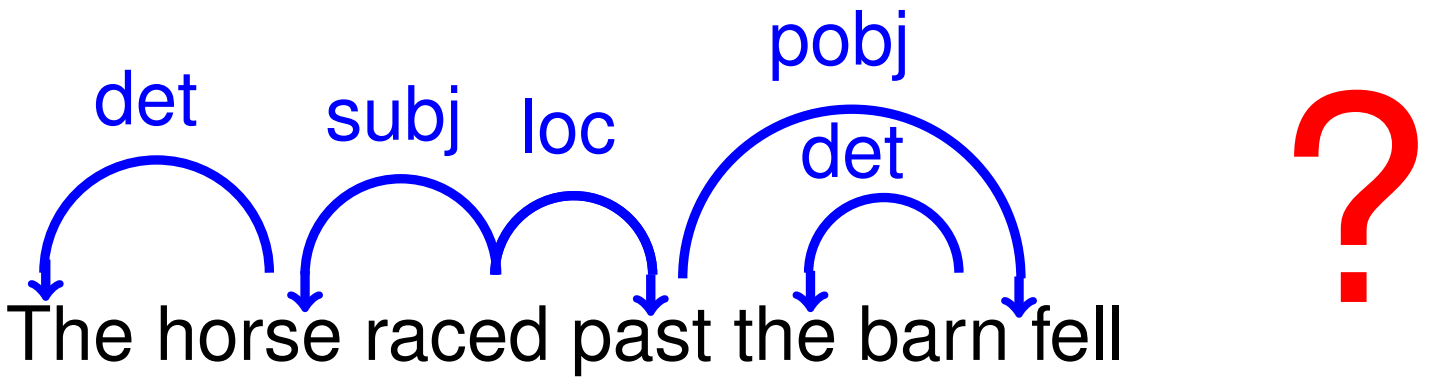
$$O(n^2)$$

Complexity of Convington's Algo



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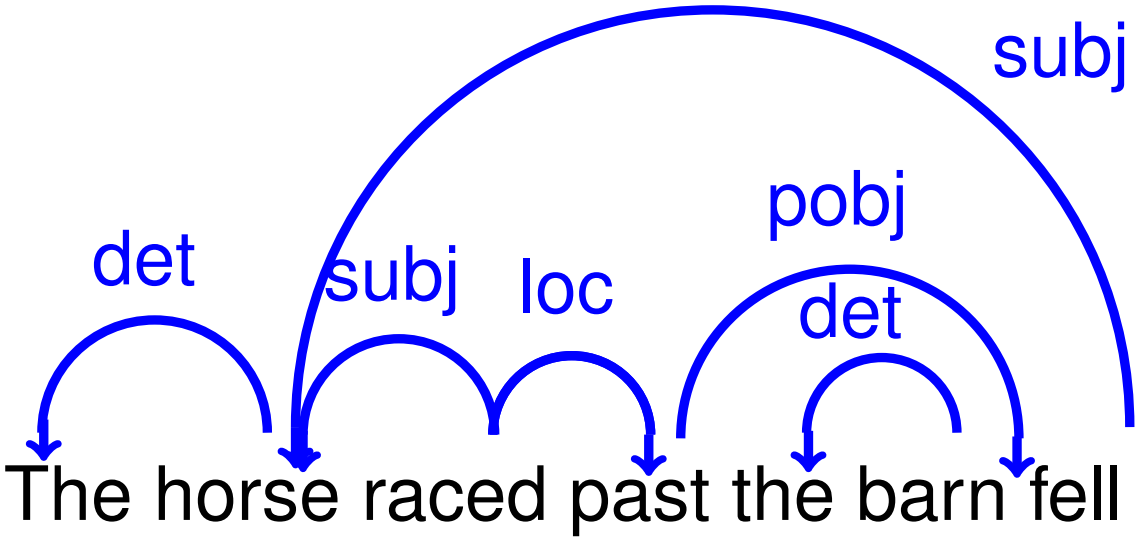

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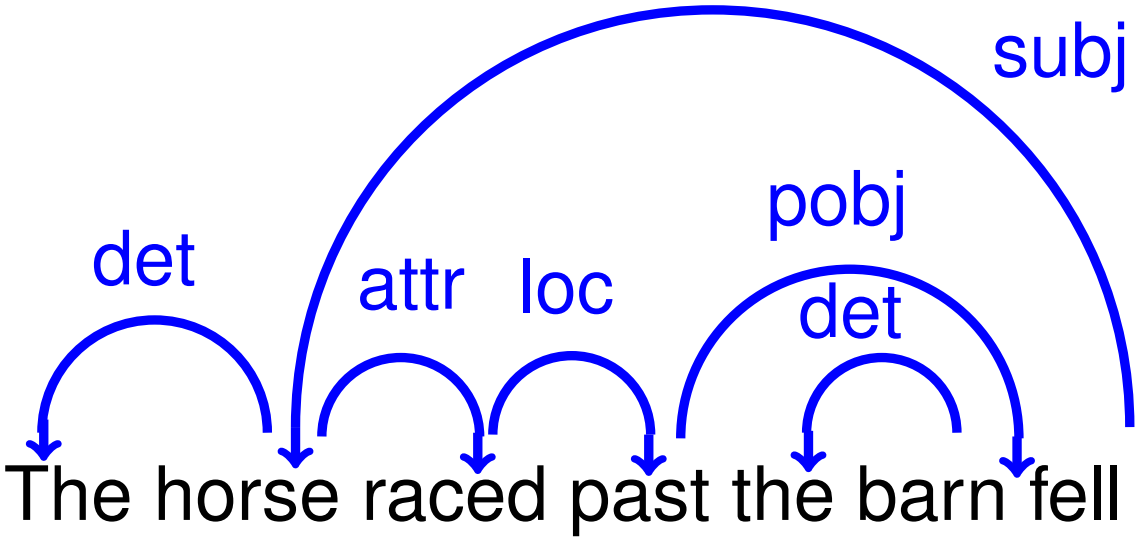
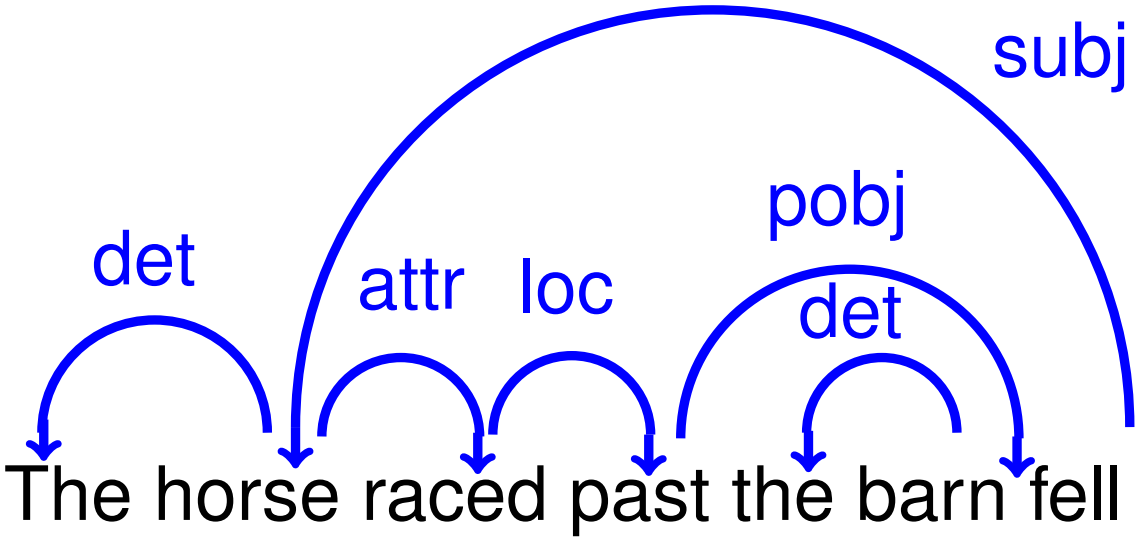


Complexity of Convington's Algo

Parse left to right, connect every word to every possible preceding word (with constant access to the grammar): $O(N^2)$

With backtracking: $O(N^3)$



Parsing

When lexical ambiguity and agreement are present, parsing is NP-complete.

Barton et al: Computational Complexity and Natural Language.

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Convington: A Fundamental Algorithm for Dependency Parsing

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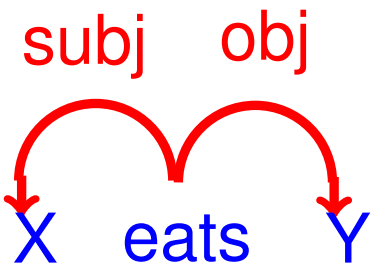
Convington: A Fundamental Algorithm for Dependency Parsing

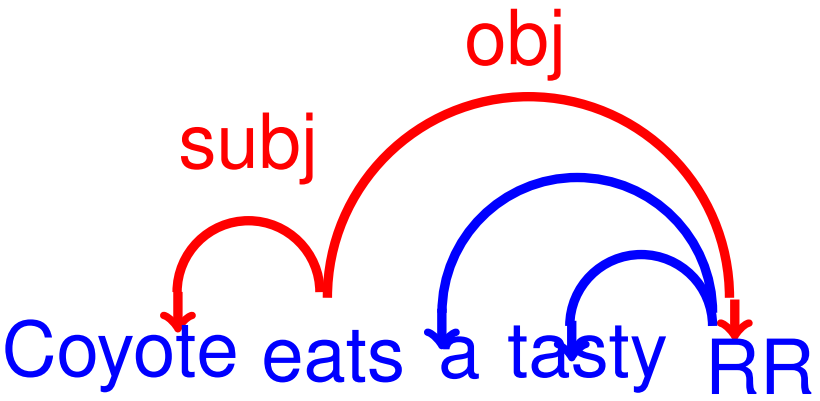
Dependency parsing works very well in practice.

Def: Dependency Patterns

A dependency pattern is a chain graph whose nodes are words or X or Y.

A dependency pattern p matches a dependency graph g, if there is a substitution σ for X and Y such that $\sigma(p) \subseteq g$.





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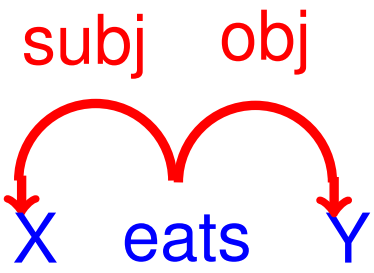
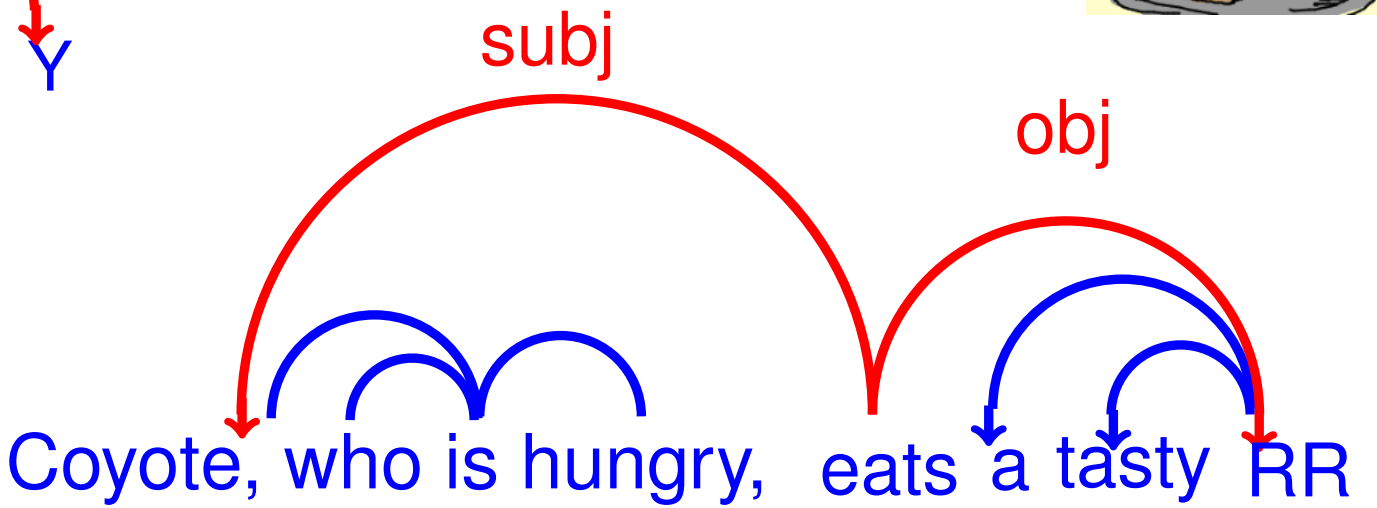
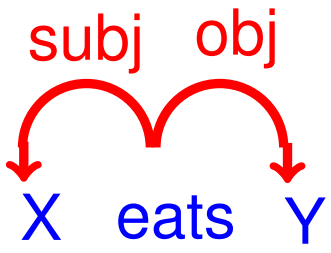
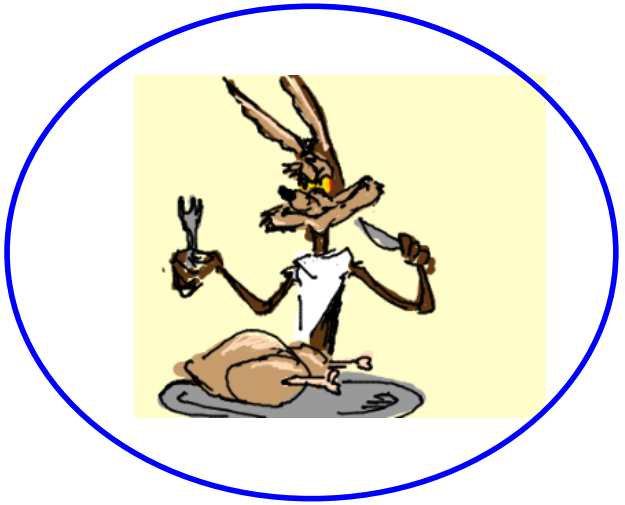
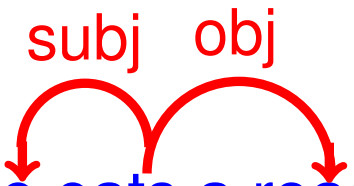




... but not all problems are solved







Coyote dreams that Coyote eats a roadrunner.

->ie-by-reasoning