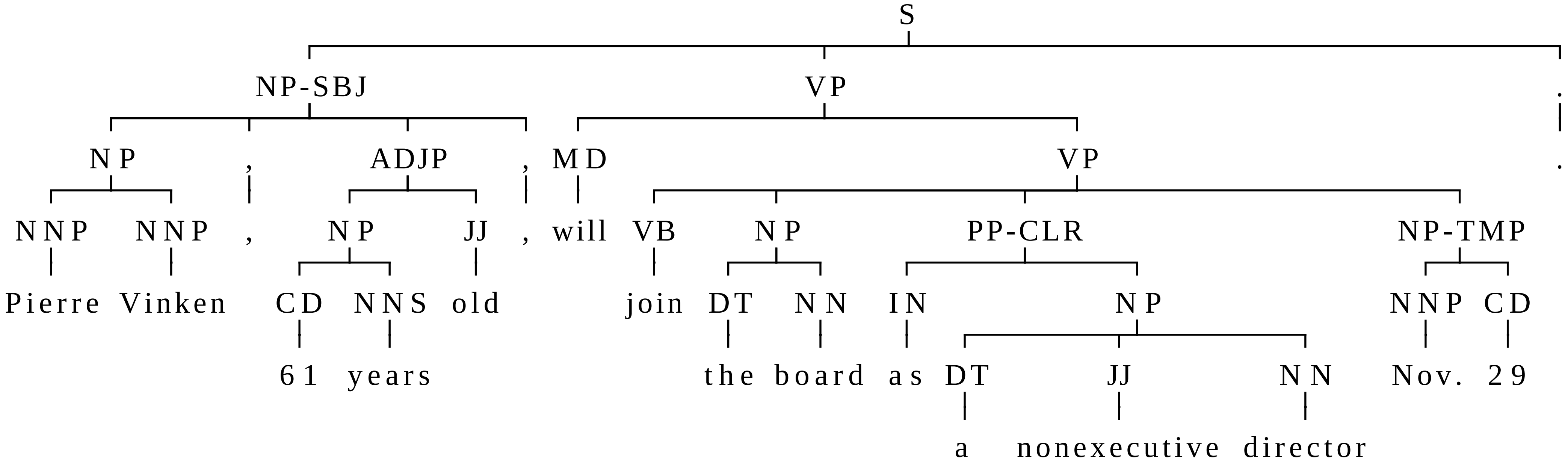
Grammar Formalisms

Yoav Goldberg

(TAG slides by Julia Hockenmaier)

Some Examples of Trees
(from the Penn Treebank Corpus)



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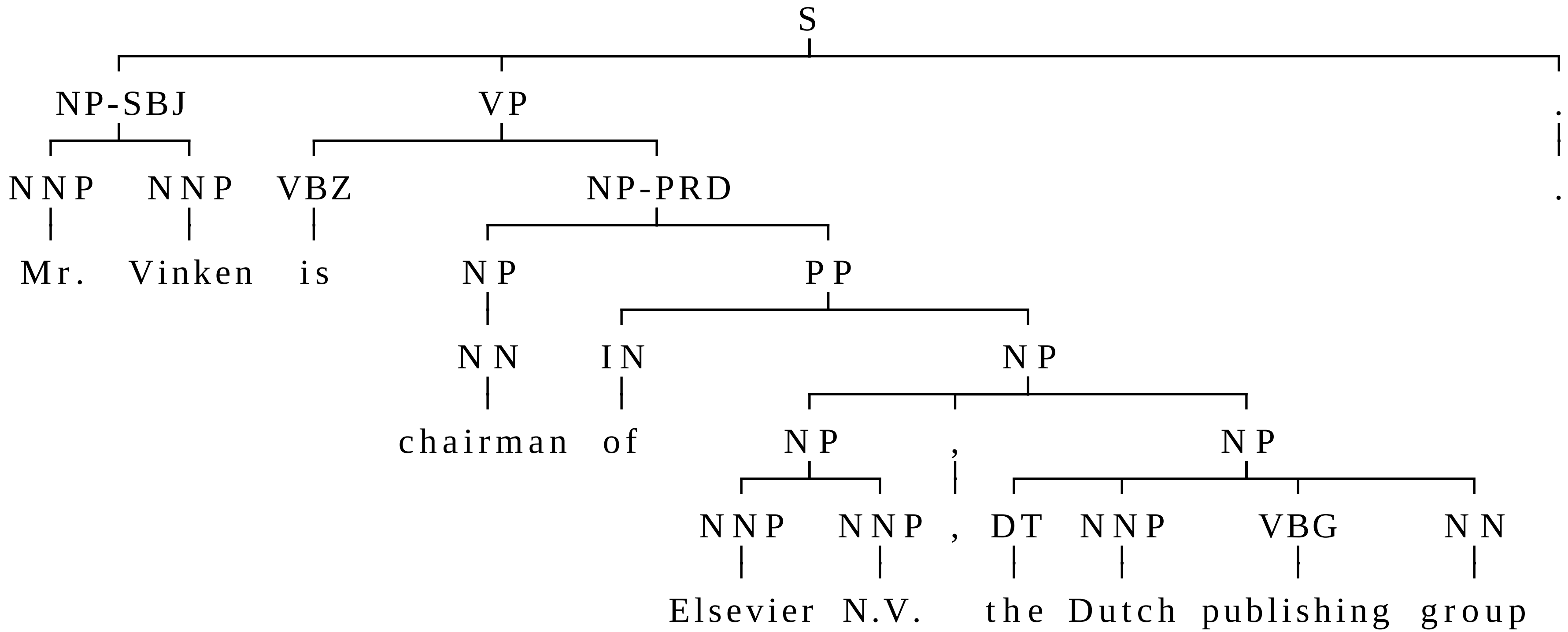
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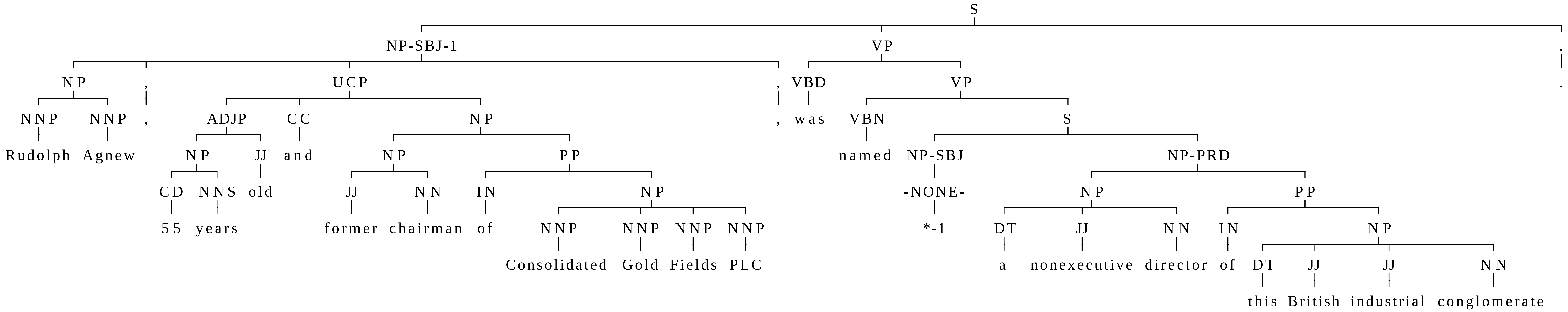
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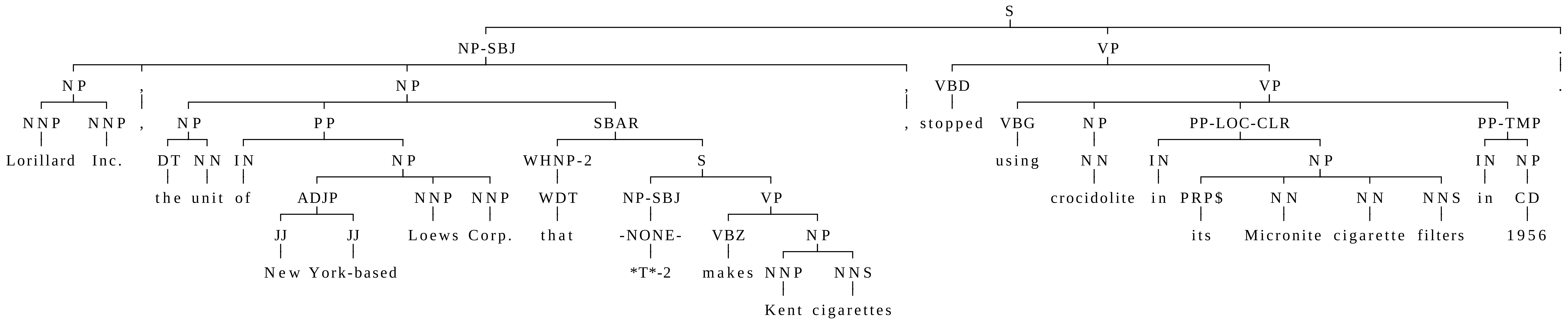
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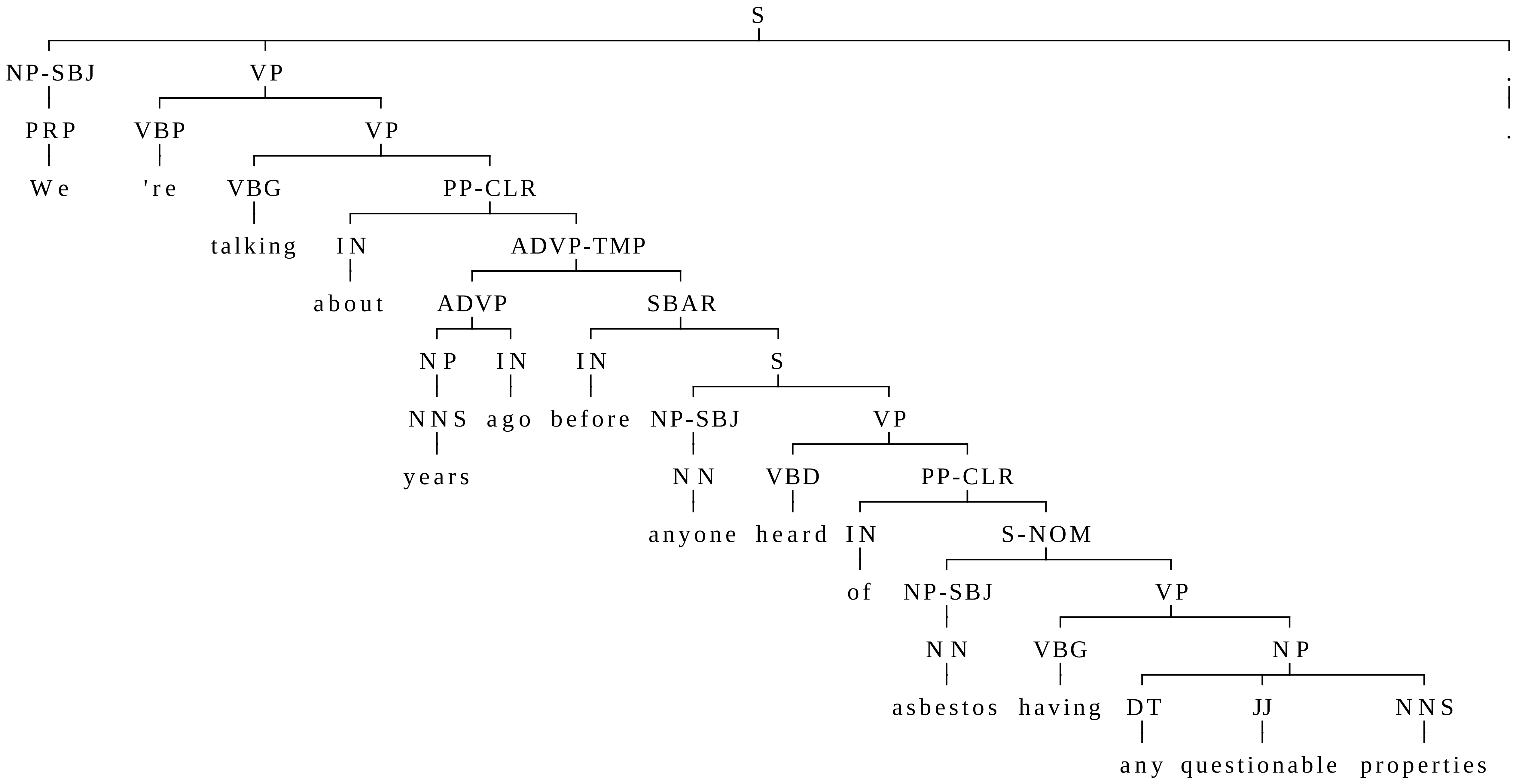
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anyone
heard
IN
S-NOM
of
NP-SBJ
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asbestos
having
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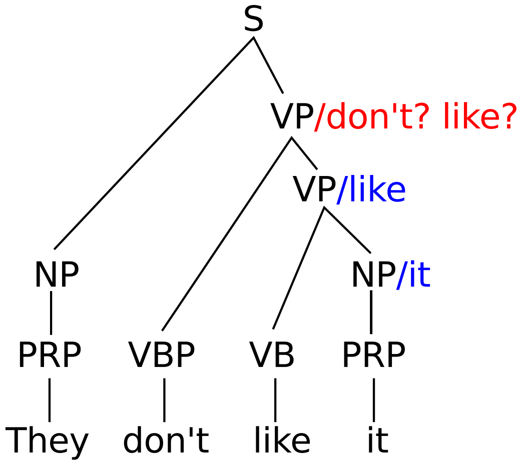
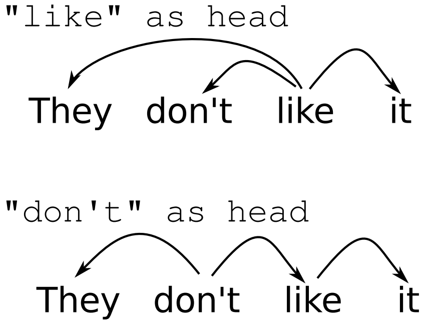
any
questionable
properties

Constituents → Heads → Dependencies

The choice of heads determines the dependency structure





Tree-Adjoining Grammar

Defining a grammar formalism

- **The conventional way**
  - Define simple elementary objects (e.g. words)
  - Define various operations to combine these objects.
  - Introduce new operations to deal with more complex structures.

- **The TAG way: Complicate locally, simplify globally**
  - Define complex elementary objects (e.g. trees) that capture crucial linguistic properties.
  - Define simple, general operations to combine these objects.
  - *What kind of predictions does this system make?*

- **[A. Joshi, *Starting with complex primitives pays off*, Cognitive Science (2004)]**

(Lexicalized) Tree-Adjoining Grammar

- **TAG is a tree-rewriting formalism:**
  - TAG defines operations (**substitution**, **adjunction**) on trees.
  - The **elementary objects** in TAG are trees (not strings)
- **TAG is lexicalized:**
  - Each elementary tree is **anchored** to a lexical item (word)
  - "**Extended domain of locality**":
    The elementary tree contains all arguments of the anchor.
  - TAG requires a linguistic theory which specifies the shape of these elementary trees.
- **TAG is mildly context-sensitive:**
  - can capture Dutch cross-serial dependencies
  - but is still efficiently parseable

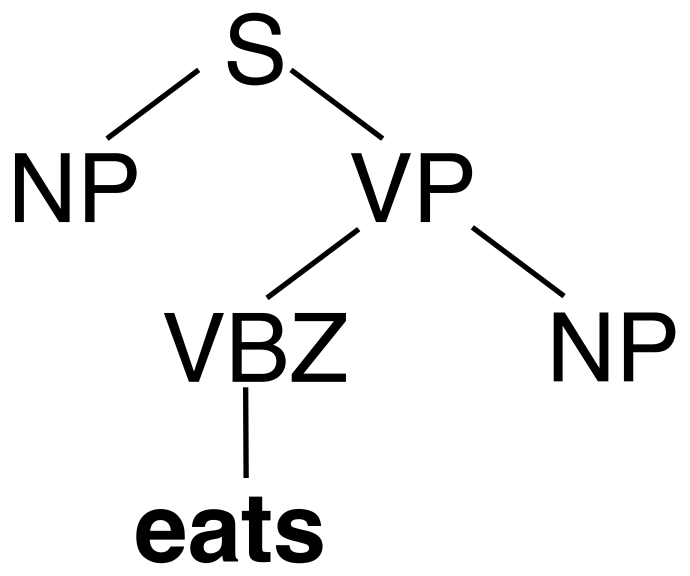
AK Joshi and Y Schabes (1996) Tree Adjoining Grammars.

Domain of locality

- In a CFG, the domain of locality is confined to a single rule.
- Each local tree is independent.

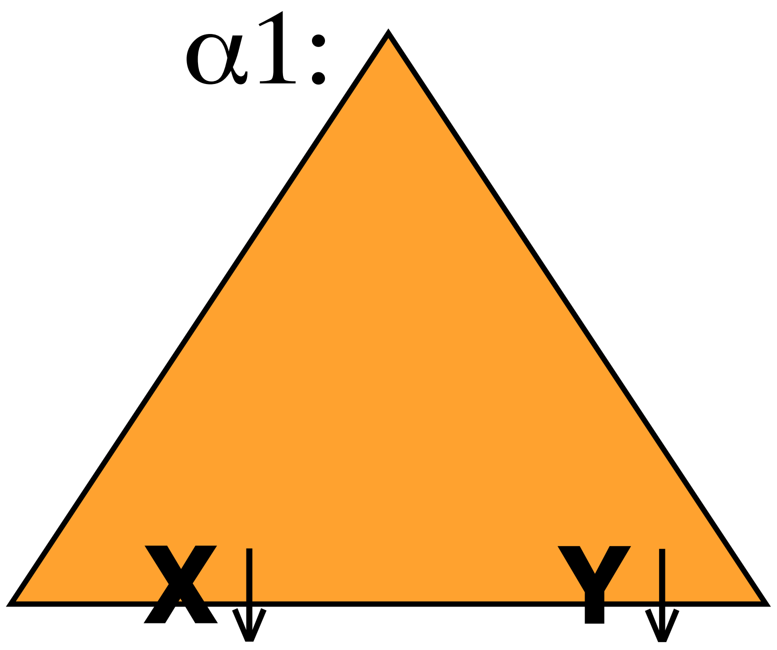
Extended domain of locality

- We want to capture all arguments of a word in a single elementary object.
- We also want to retain certain syntactic structures (e.g. VPs).
- Our elementary objects are tree fragments:

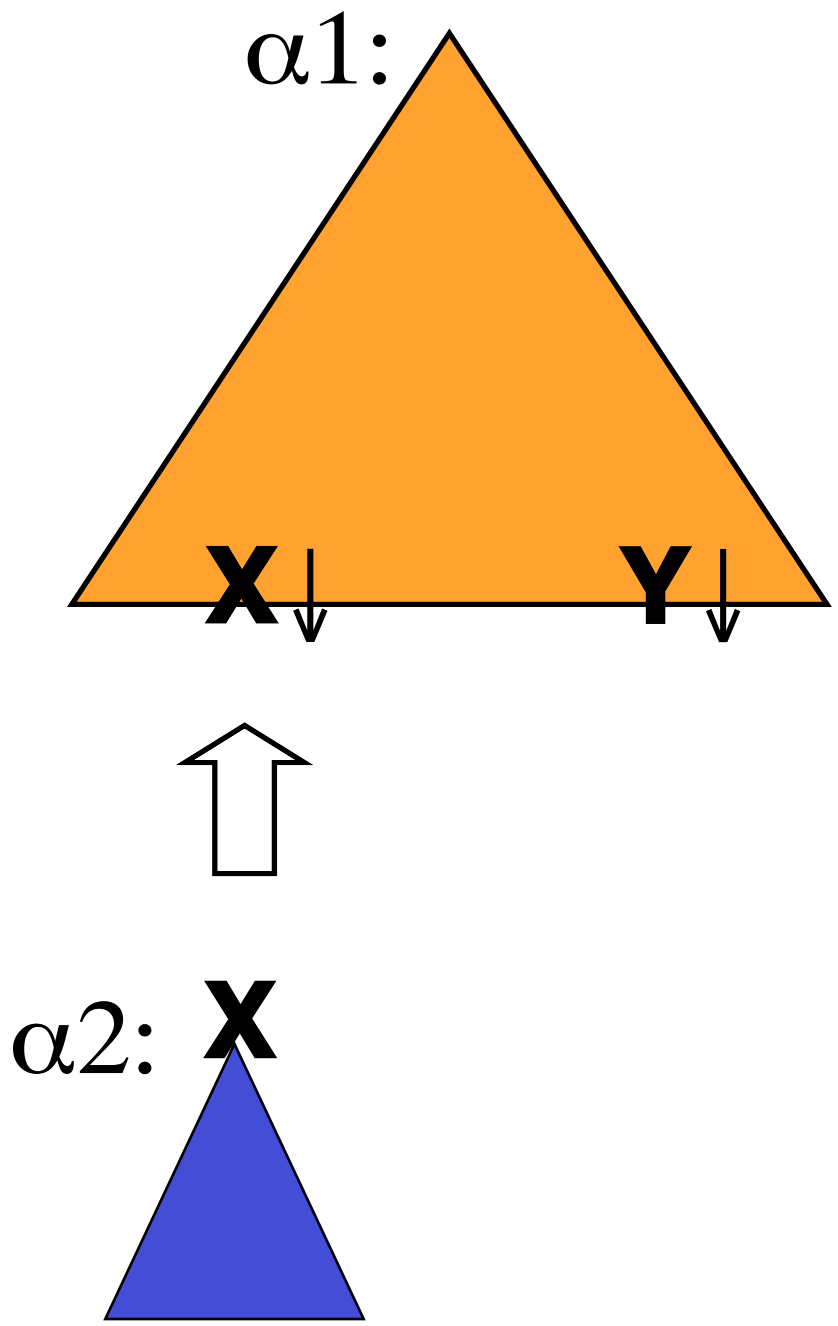


TAG substitution (arguments)

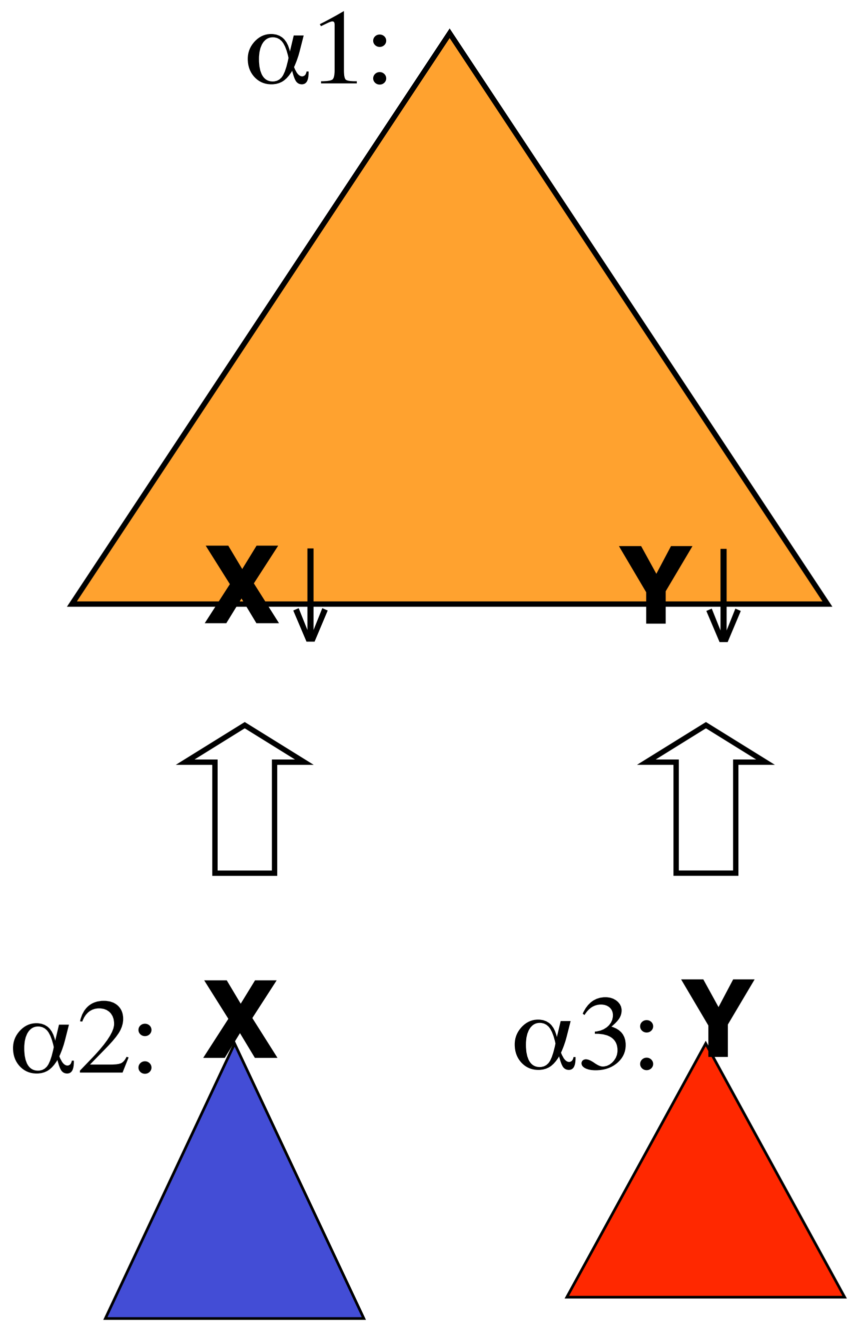
TAG substitution (arguments)



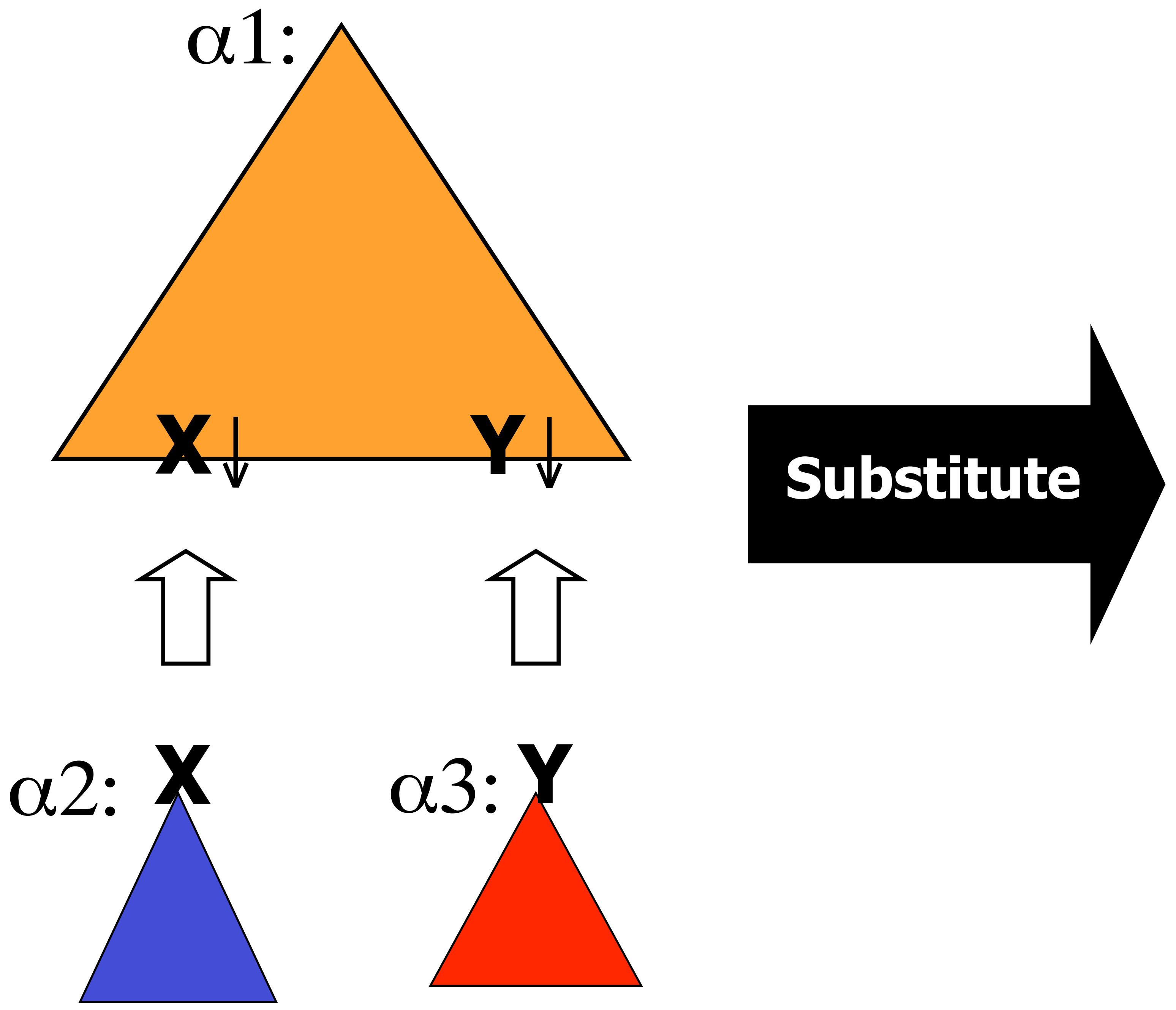
TAG substitution (arguments)



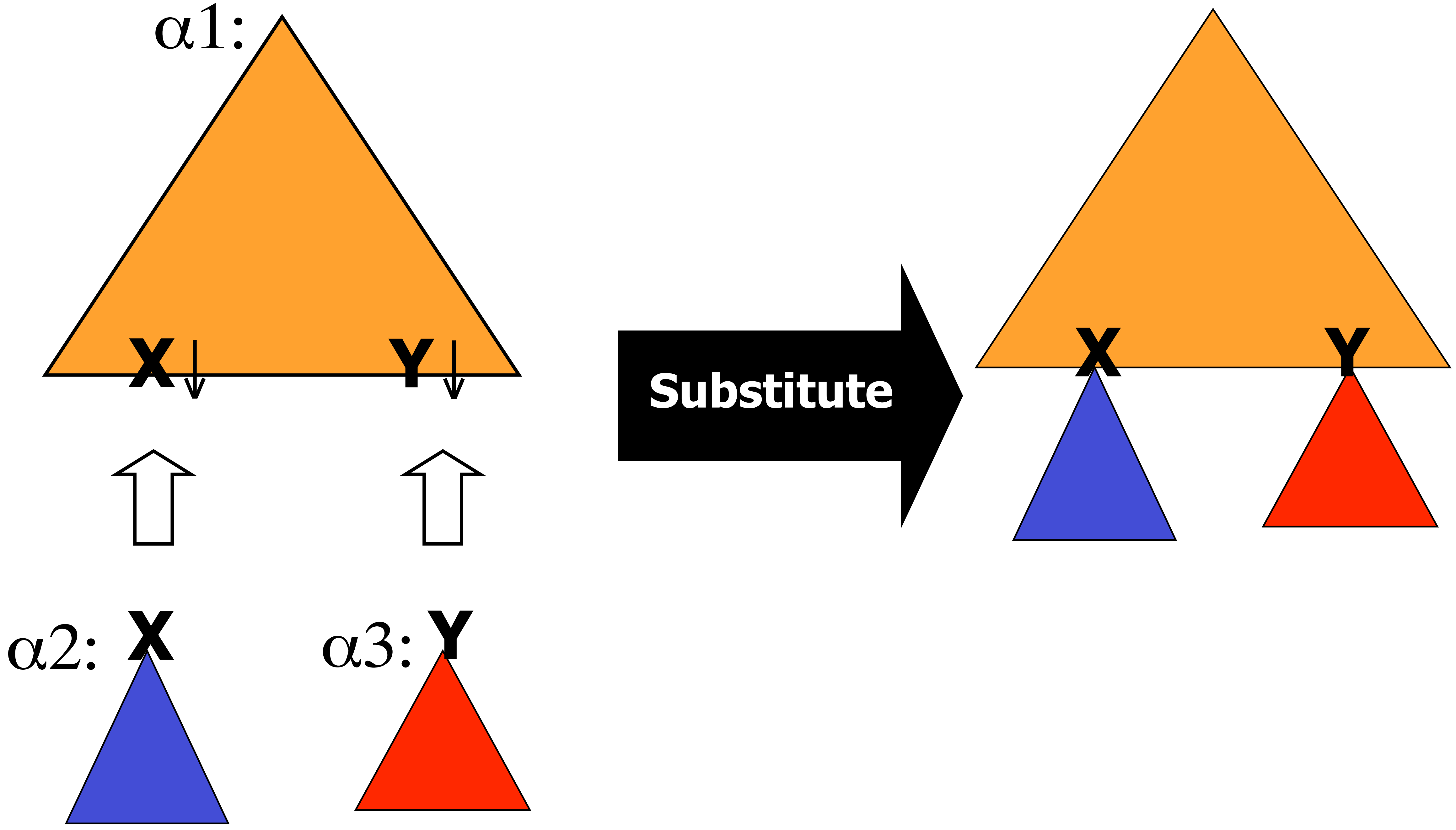
TAG substitution (arguments)



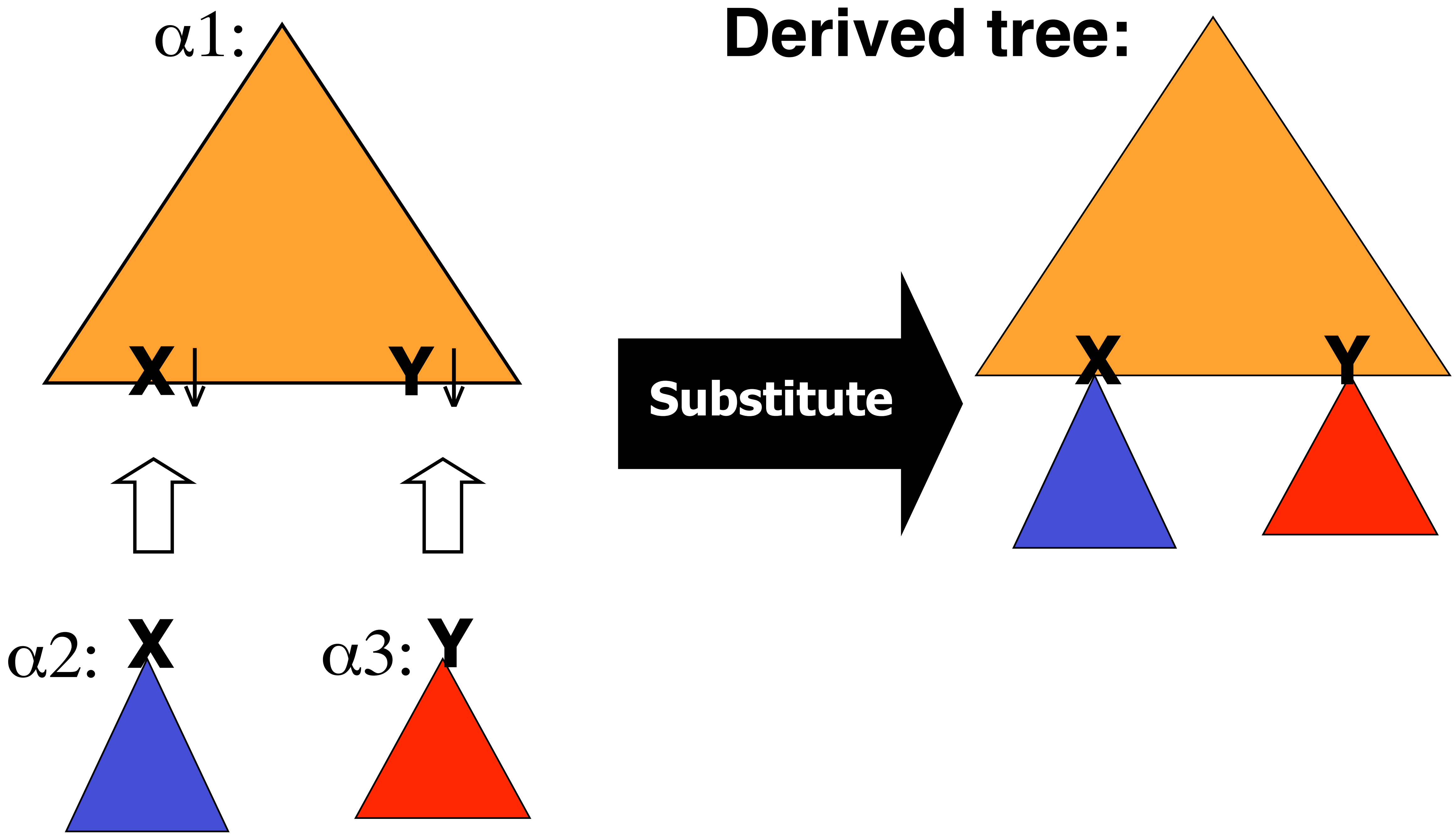
TAG substitution (arguments)



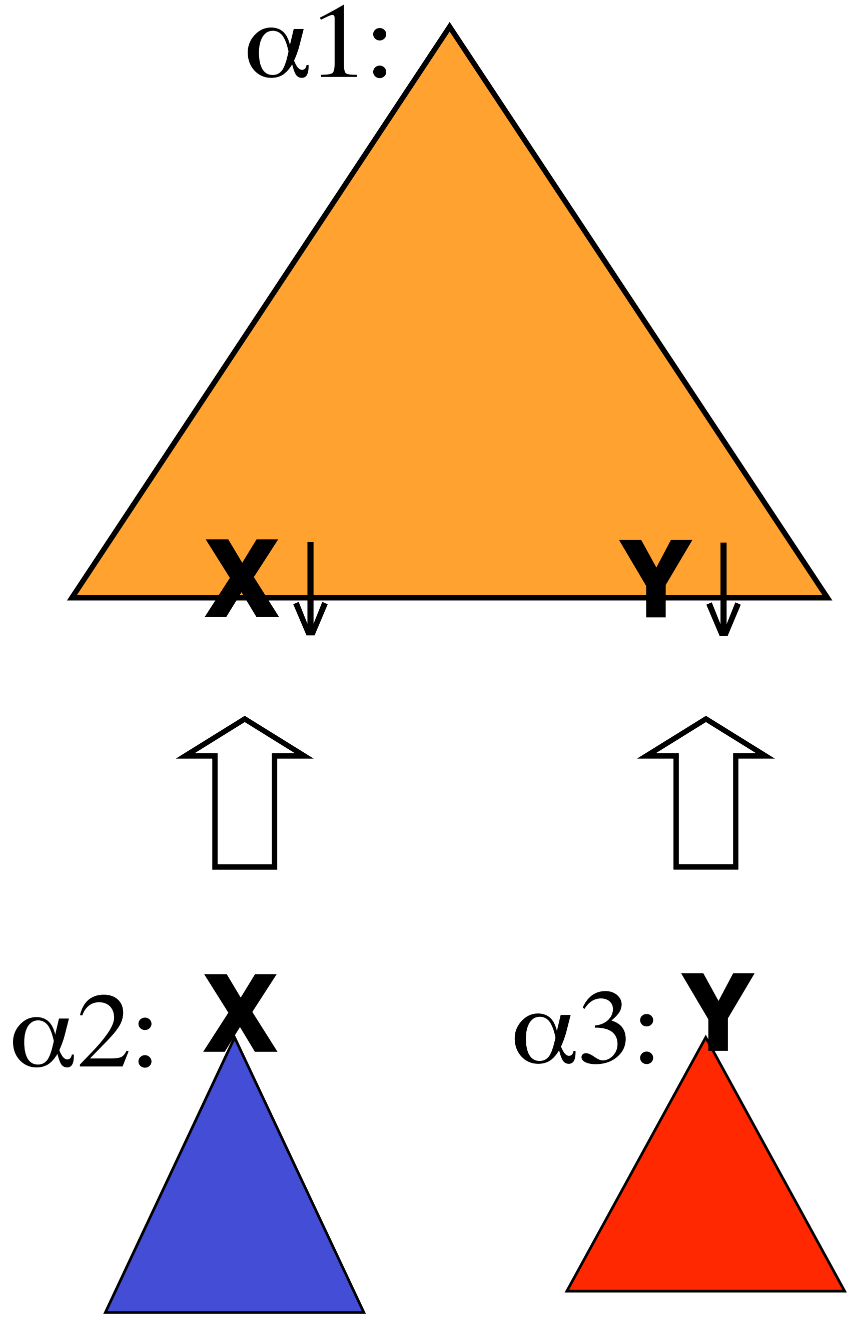
TAG substitution (arguments)



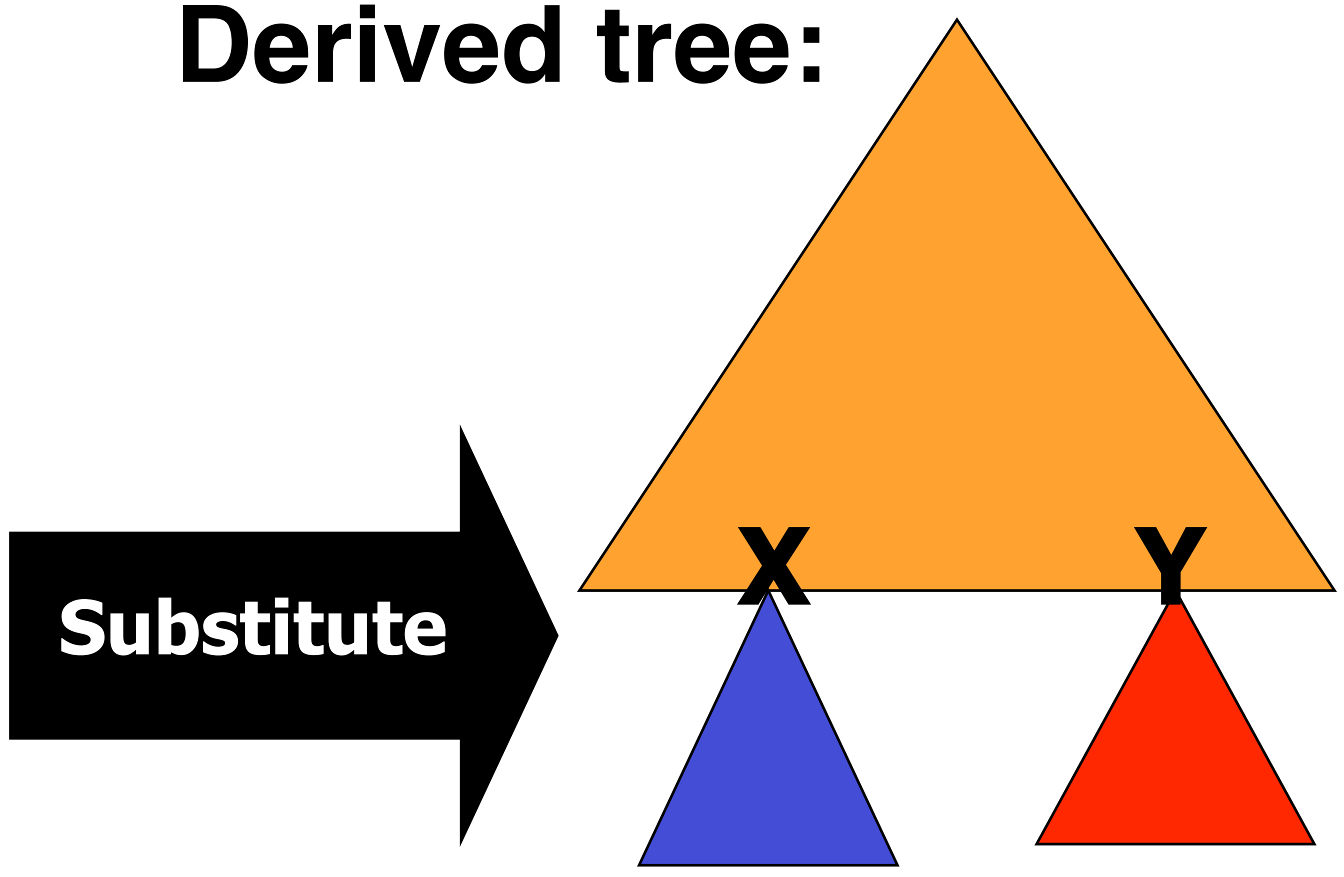
TAG substitution (arguments)



TAG substitution (arguments)

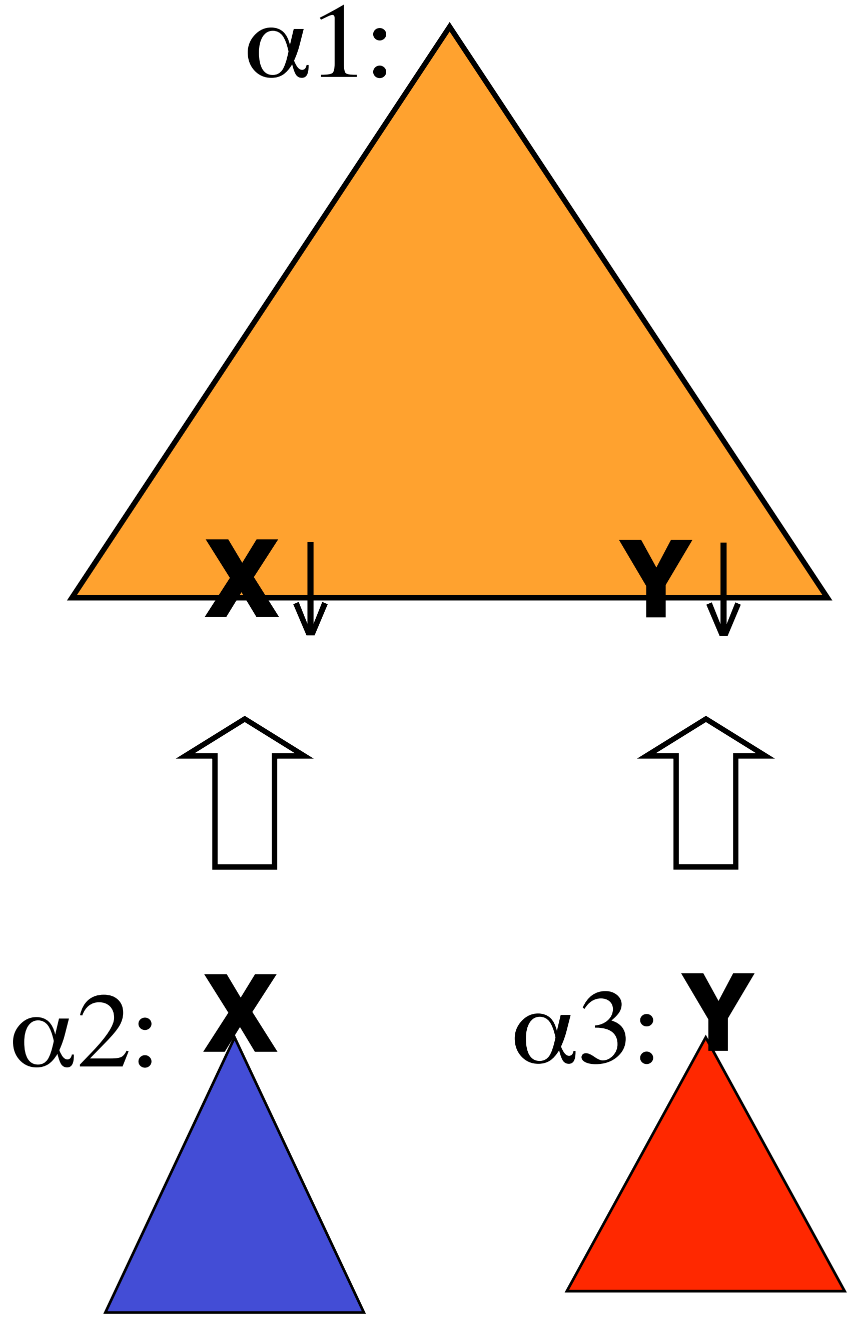


Derived tree:

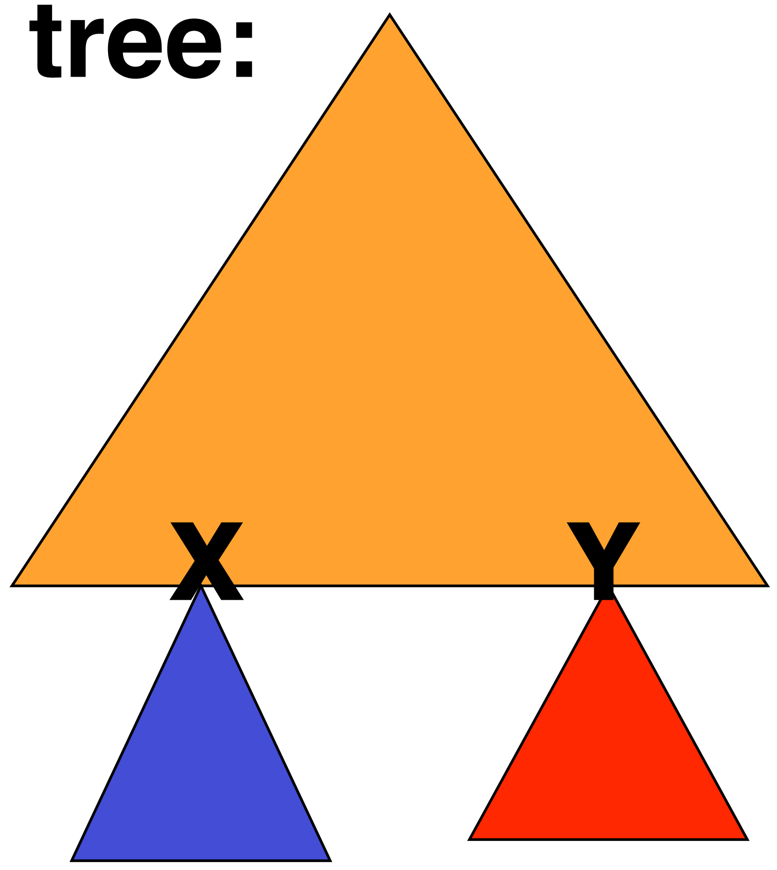


Derivation tree:

TAG substitution (arguments)



Derived tree:



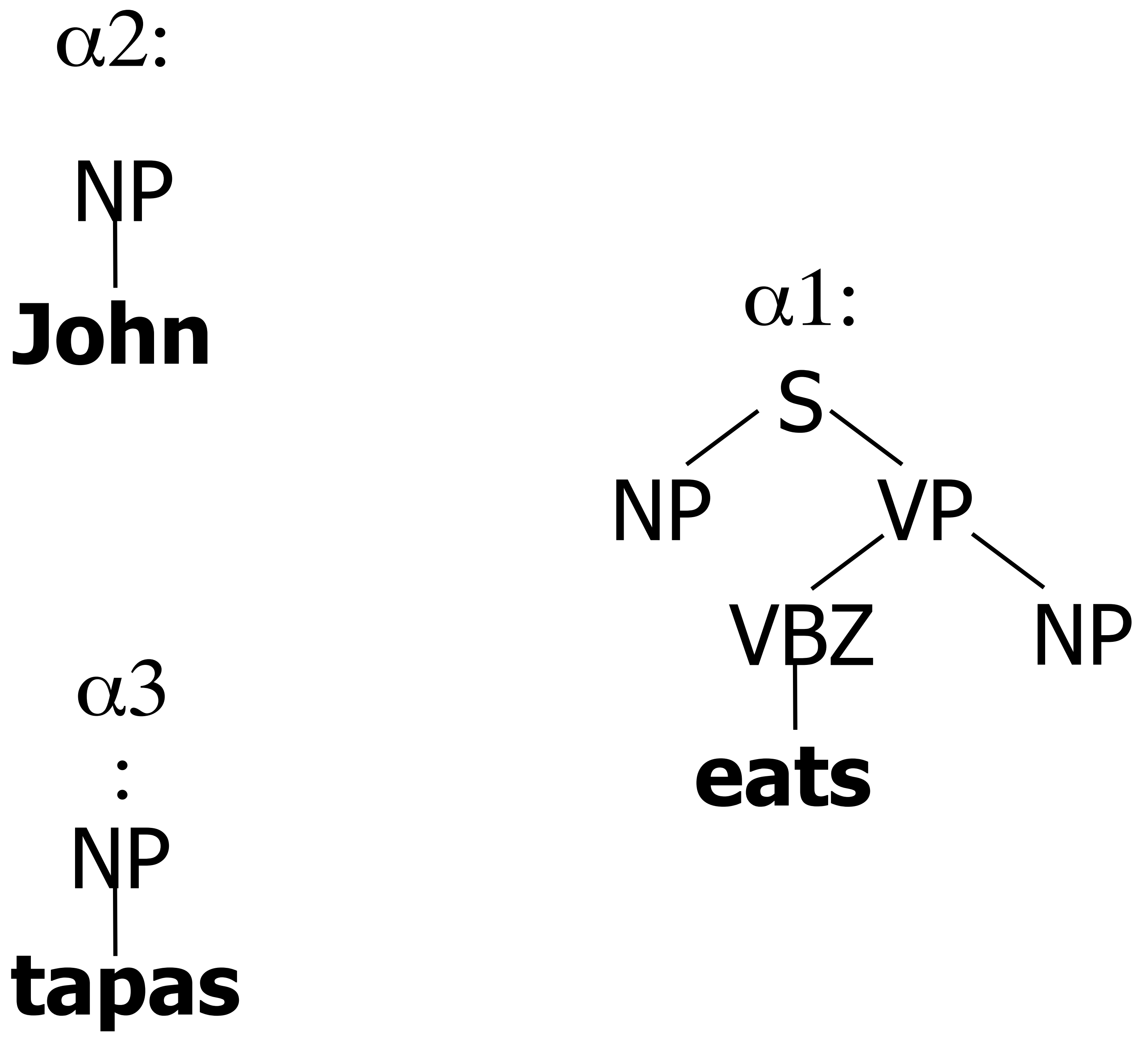
Derivation tree:

$$\begin{tikzcd}[column sep=small] & \alpha1 \arrow[dl, no head] \arrow[dr, no head] & \\ \alpha2 & & \alpha3 \end{tikzcd}$$

Tree-Substitution Grammar

- **TAG without adjunction**
  = Tree-substitution grammar.
  - elementary objects = trees.
  - recursive operation: substitution
- **Substitution alone does not give us anything beyond context-free grammar.**

A small TSG lexicon


α2:
NP
John
α1:
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α3
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