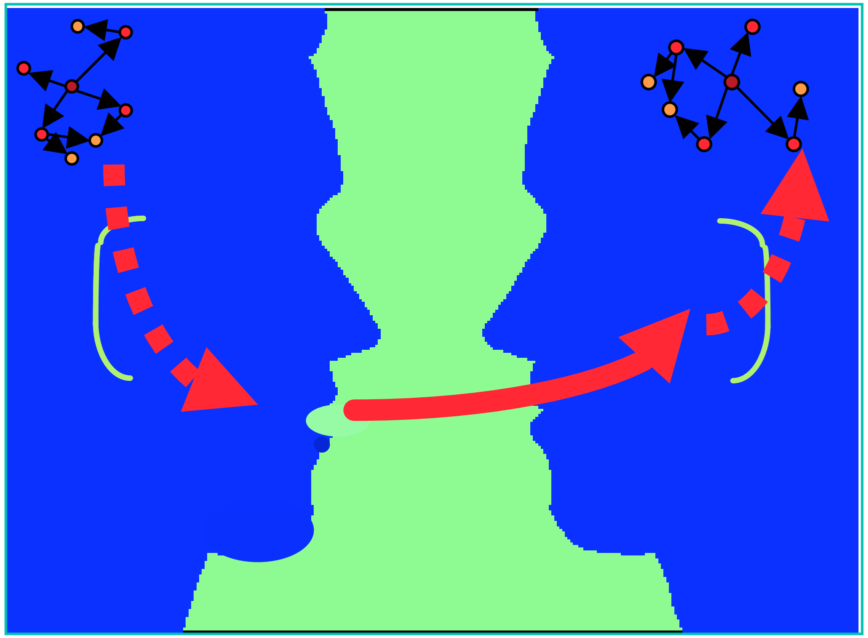
FLST

Grammars and Parsing

Hans Uszkoreit

WHAT HAPPENS IN BETWEEN?



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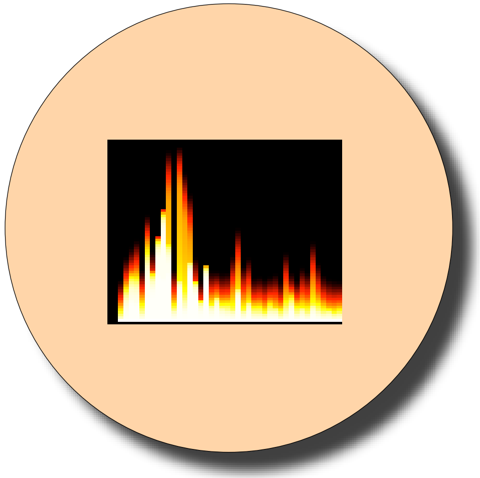

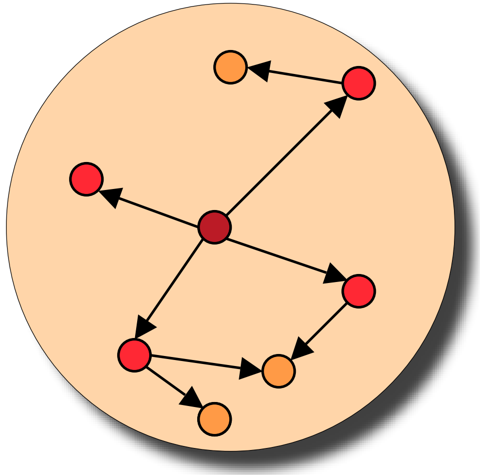

sound waves

activation of concepts

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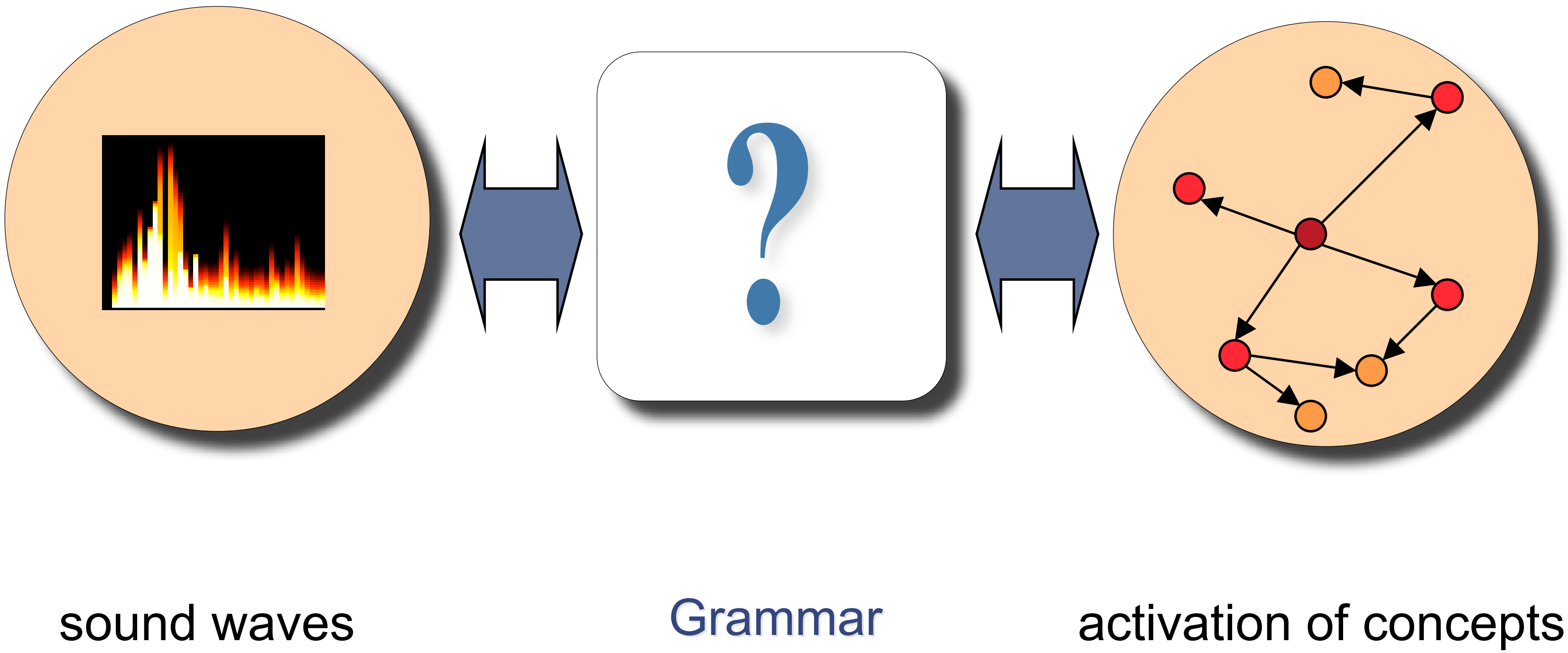

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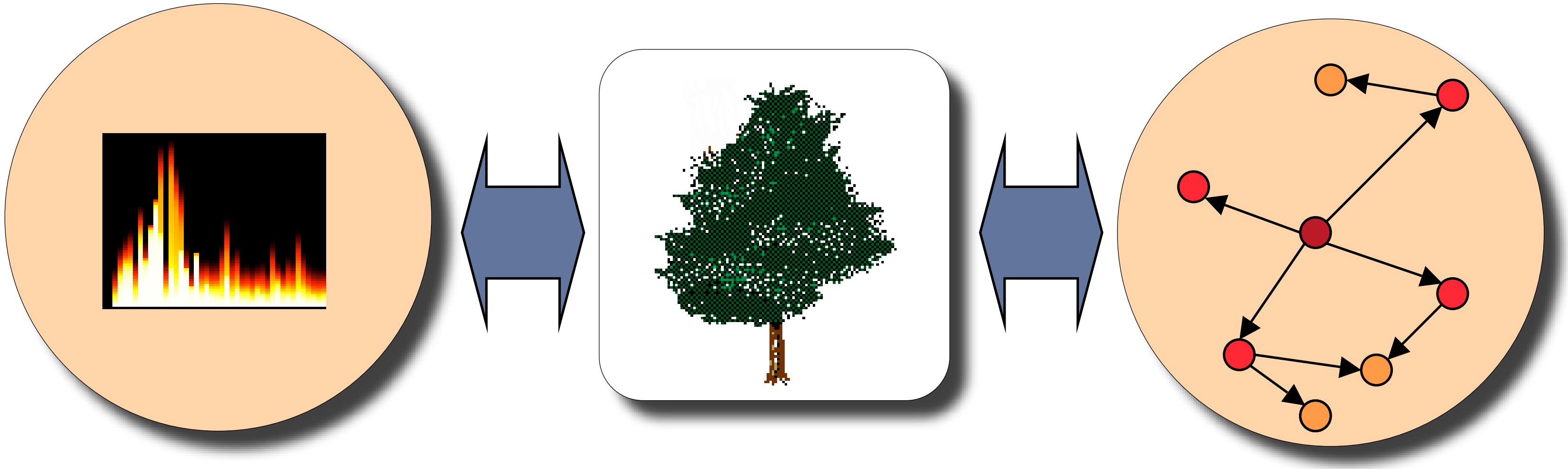

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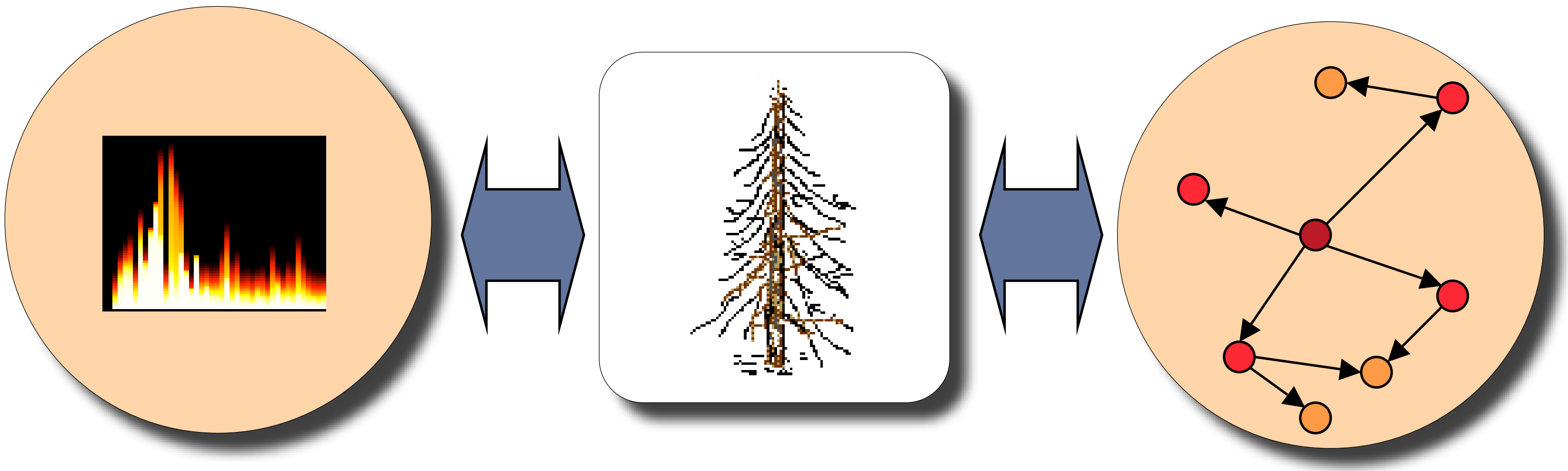

sound waves | Grammar | activation of concepts

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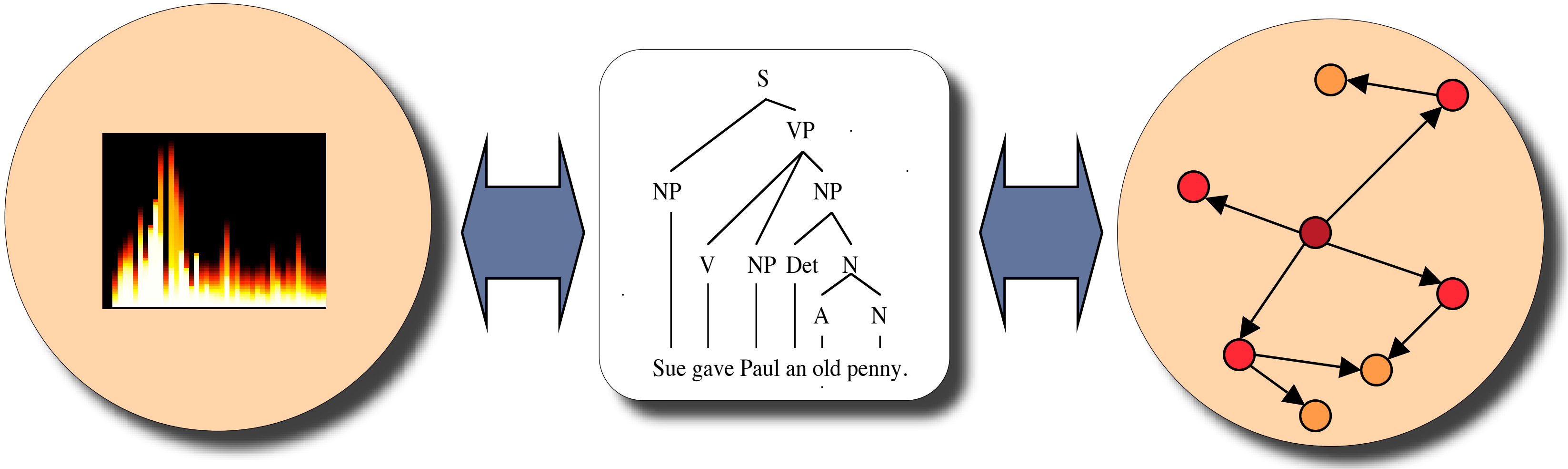

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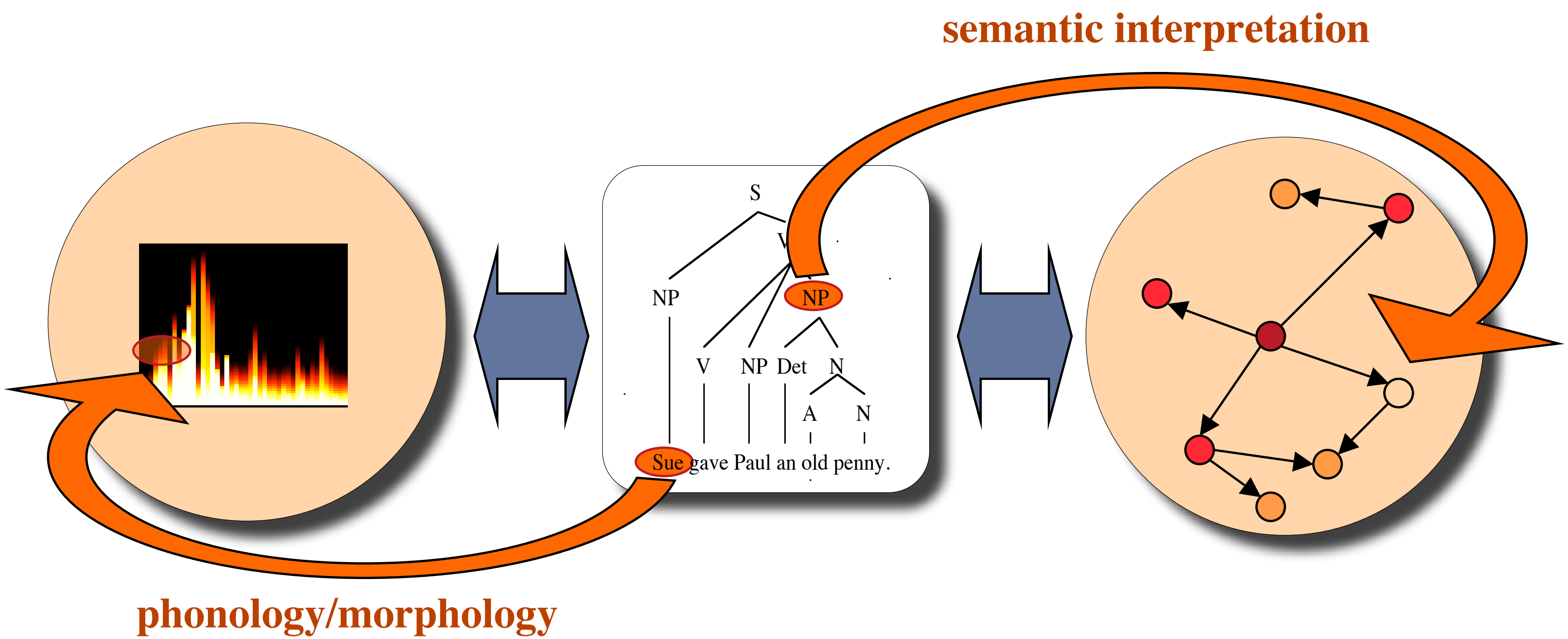

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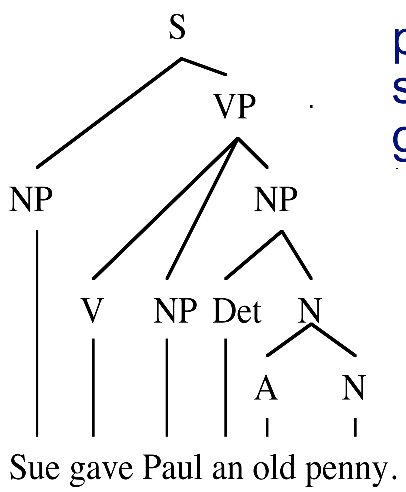
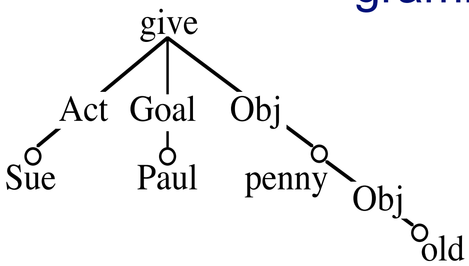
THREE TRADITIONS

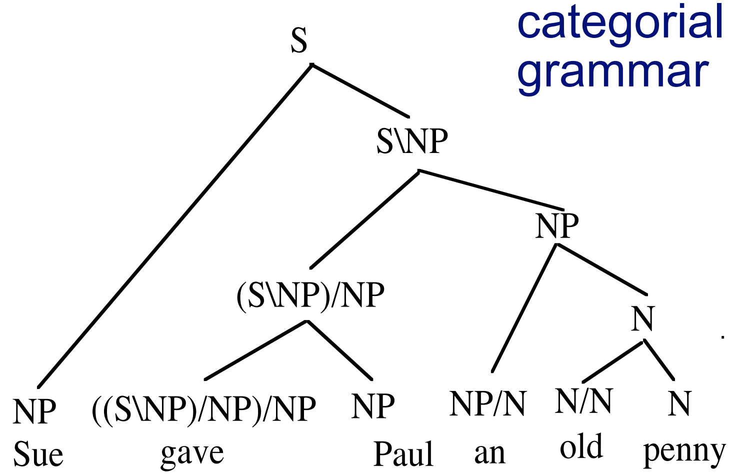


phrase structure grammar

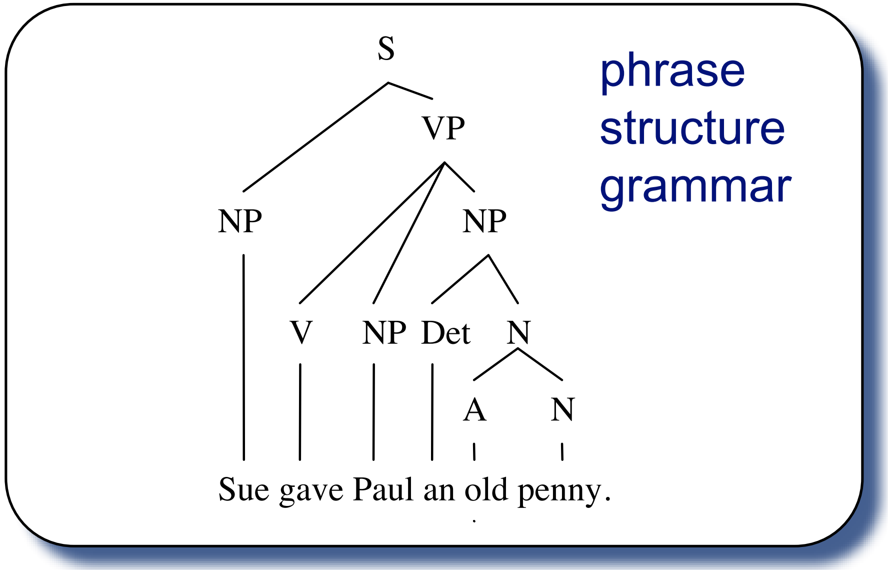
dependency grammar



categorial grammar

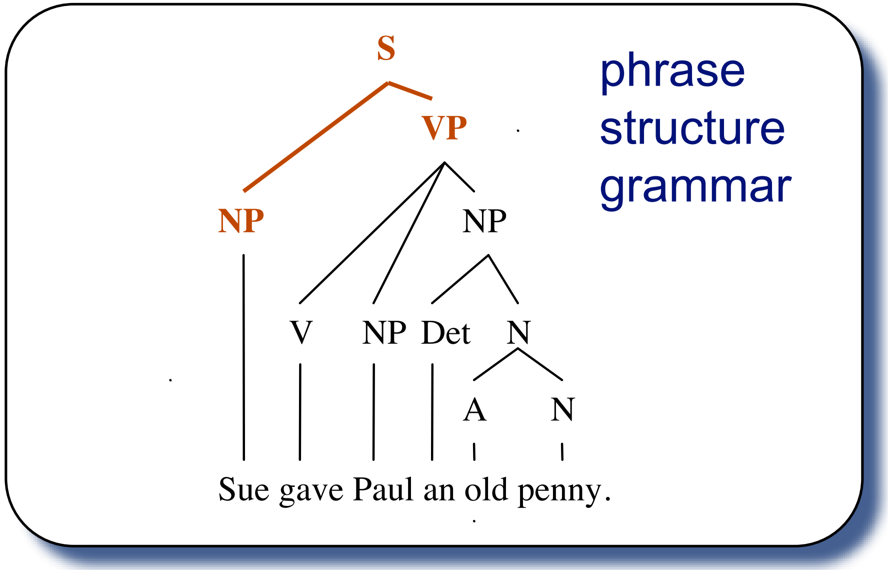


Grammatik



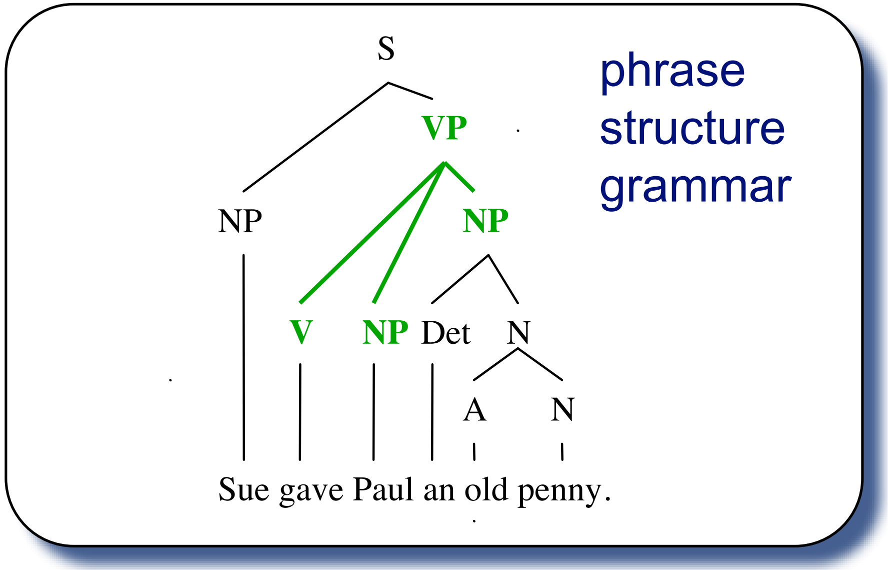
S → NP VP

Grammatik



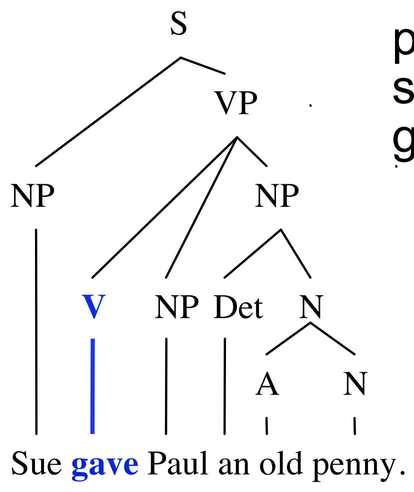
S → NP VP

Grammatik



S → NP VP
VP → V NP NP

Grammar



phrase structure grammar

S → NP VP
VP → V NP NP

V → gave

symbol conventions

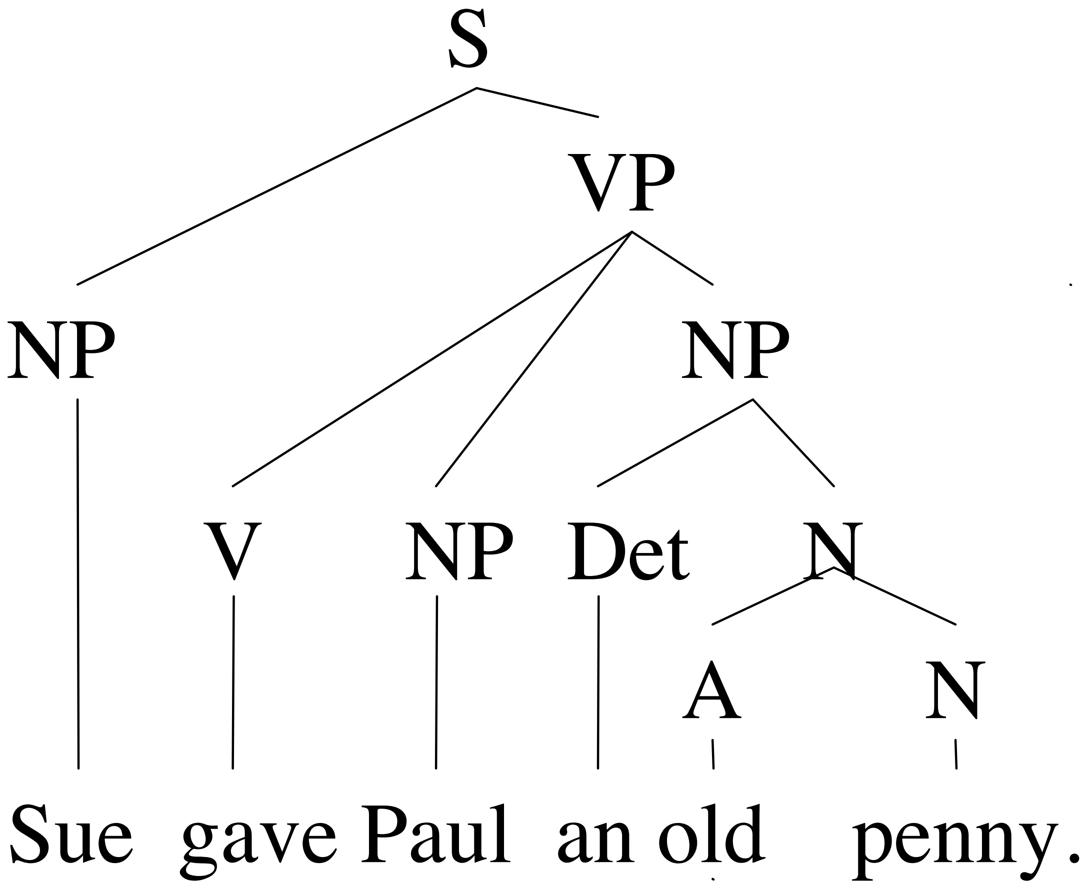
	single symbols	strings
non-terminal	A, B, C, ...	... , X, Y, Z
terminals	a, b, c, ...	... , x, y, z
unspecified symbols	$\alpha, \beta, \gamma, \ldots$	$\ldots, \phi, \chi, \psi, \omega$
start symbol	S	
empty string	e	
integers	..., i, j, k, l, m, n, ...	

Why Syntax

- Einen Hund hat dieser Mann gebissen.
- Ein Hund hat diesen Mann gebissen.

- This man has bitten a dog.
- A dog this man has bitten.
- A dog has bitten this man.

- Peter promised Paul, to process the files.
- Peter persuaded Paul, to process the files.


S
VP
NP
NP
V
NP
Det
N
A
N
Sue gave Paul an old penny.

Formal Grammar

A language over an alphabet (vocabulary) Σ is a subset of Σ^*.

A formal grammar G_L for a language L is a quadruple $(V_N, V_T, \{S\}, P)$.

V_N - non-terminal vocabulary (auxiliary vocabulary)

V_T - terminal vocabulary

$(V_T \cap V_N = \emptyset, \quad L \subseteq V_T^*, \quad V = V_T \cup V_N)$

{S} - singleton with the start symbol (set of axioms)

P - set of productions, rule set

set of rules of the form $\omega_1 \phi \omega_2 \rightarrow \omega_1 \psi \omega_2$

usually written as $\phi \rightarrow \psi$

<u>relation “follows":</u>

If G = (V_N, V_T, {S}, P), then ψ follows from ϕ according to G iff there are strings ϕ_1, ϕ_2, χ, ω, so that $\phi = \phi_1, \chi, \phi_2$ und $\psi = \phi_1, \omega, \phi_2$ und $\chi \rightarrow \omega \in P$.

Notation: $! \ \#_{G}$

<u>derivation:</u>

A sequence of strings $\phi_1, \phi_1, ..., \phi_n$ is a derivation according to G iff $!_{i} \; {}_{G} \; !_{i+1}$ for all i, $1 \leq i \leq n$.

If there is *derivable* according to G from ϕ to ψ we can write this: $! \ \#^{*}_{G}$

The relation *derivable* is transitive and is moreover defined to be reflexive.

The generated language

<u>The language L:</u> A string ω is in L according to G_L iff the following three conditions are fulfilled:

1. $\omega \in V_T^*$
2. $S \ \underset{G}{\overset{*}{}} \ !$
3. There is no χ, so that $! \ \underset{G}{\overset{*}{\#}}$ and $\omega \neq \chi$.

We say that G_L generates the language L. The language L generated by G is also written as L(G).

<u>Weak Equivalence:</u> Two grammar G_1 and G_2 are weakly equivalent, if they generate the same language.

Types of Grammars

Type 0 (unrestricted rewriting systems):

Every formal grammar according to the definition is of type 0.

Type 1 (context sensitive grammars):

Every production is of the form $\phi A \psi \rightarrow \phi \omega \psi$, where $A \in V_N$, $\omega \neq \varepsilon$.

Type 2 (context free grammars):

Every production is of the form $A \rightarrow \omega$, where $\omega \neq \varepsilon$.

Type 3 (regular grammars):

Every production is of the form $A \rightarrow x\ B$ or $A \rightarrow x$, where $x \neq \varepsilon$.

context-free derivations

S

NP VP

DET ADJ N VP

DET ADJ N V NP

DET ADJ N V DET ADJ N

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.

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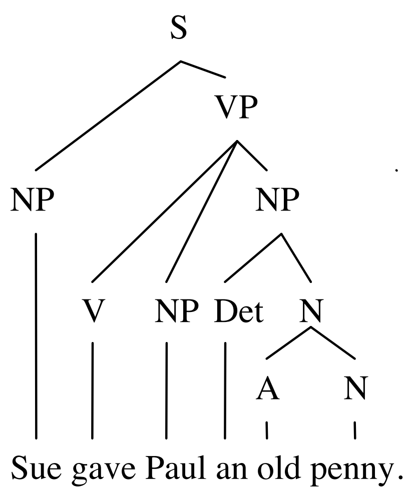
ein kleines Mädchen sucht ein kleines Mädchen

Trees

the notion of syntactic constituent tree

coded information

1. the hierarchic organisation of a sentence in terms of constituents
2. the assignment of each constituent to a linguistic class (category)
3. the linear sequence of the constituents



Trees II

relations: immediate dominance - dominance
immediate precedence - precedence

constituent structure tree: quintuple(N, Q, D, P, L)

N - finite set of nodes
Q - finite set of labels
D - weak partial order in N x N, the dominance relation
(reflexive, transitive und antisymmetric)
P - strong partial order in N x N, the precedence relation
(irreflexive, transitive und asymmetric)
L - function from N into Q, the labelling function

conditions:

(single) root condition
exclusivity condition
no crossing condition / no tangling condition

Conditions

root condition

There is exactly one node that dominates all other nodes of the tree.

exclusivity condition

For any two nodes x and y holds either D(x,y) or D(y,x)
or P(x,y) or P(y,x)
but never both.

no-tangling condition

If P(x,y) then for all x' dominated by x [D(x,x')] and for all y' dominated by y [D(y, y')] that x' precedes y' [P(x', y')]

Parsing

- The syntactic analysis of strings according to a grammar we call parsing
- input: terminal string

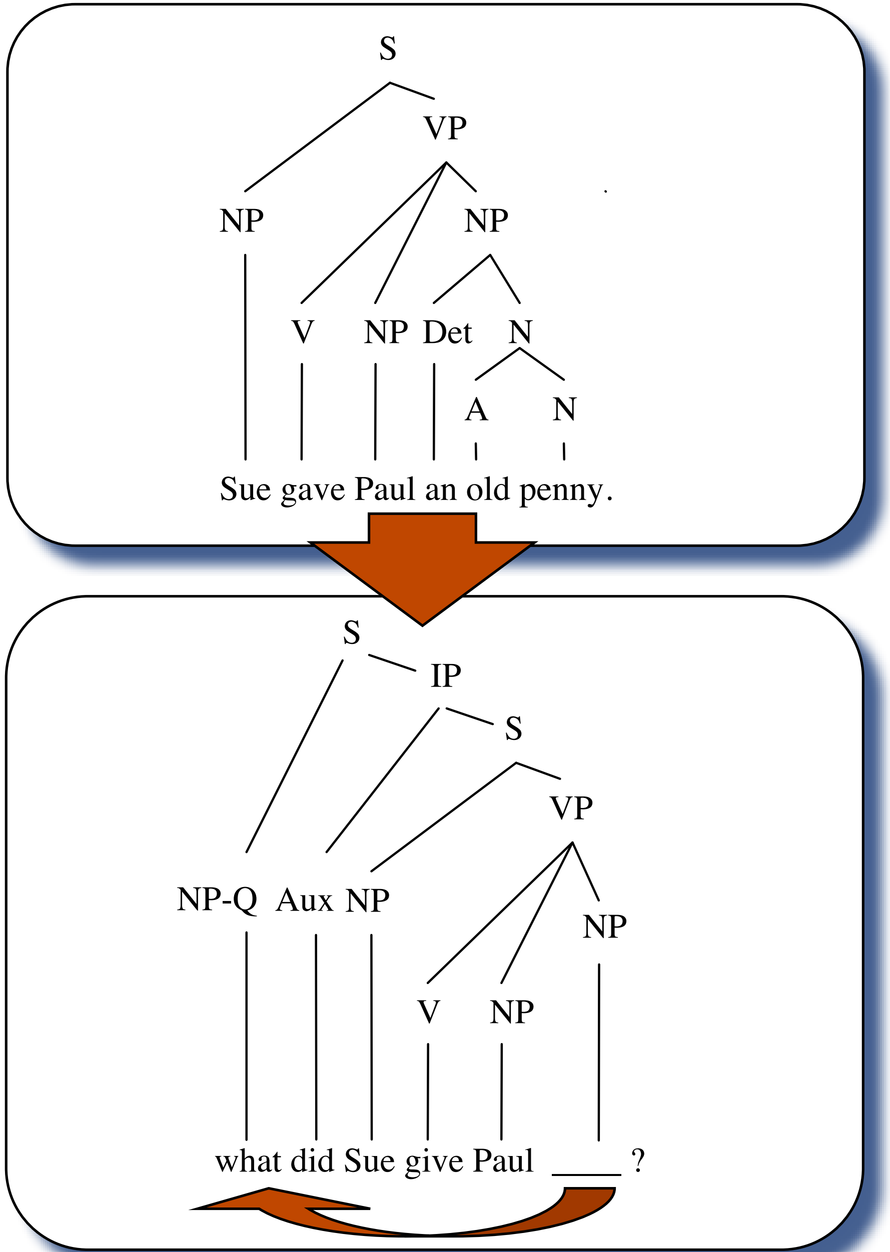
  output: structure of the sentence, i.e. all constituents usually a tree
- parsing algorithms:

  top-down vs bottom-up

  left-right vs right left vs birectional or island parsing

  deterministic vs. non-deterministic

Grammar



transformational grammar

Grammar

Unification grammar