Separating Dependency from Constituency in a Tree Rewriting System

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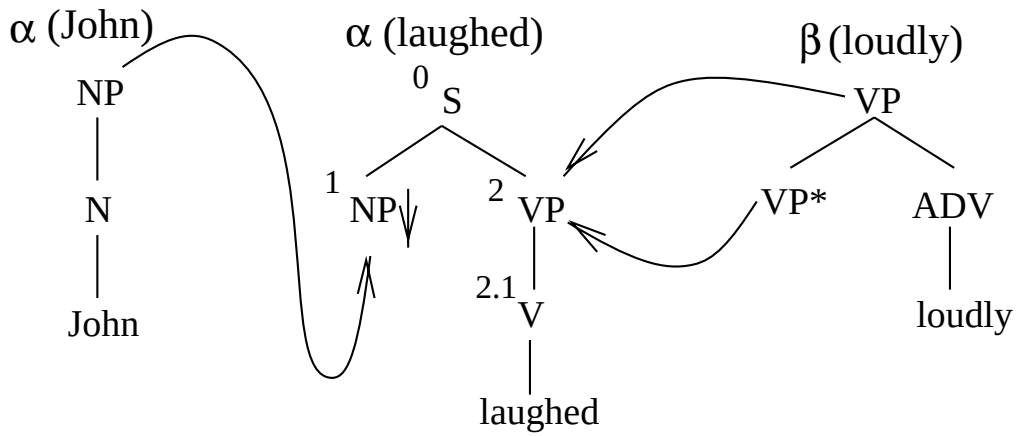
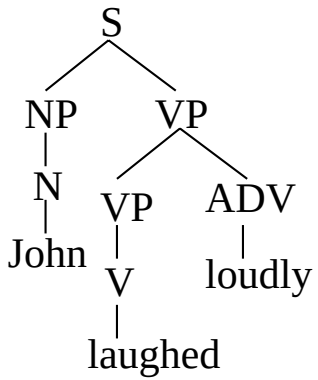
Motivation

- TAG: reconcile locality and endemic treatment of long distance dependency with coordination
- most successful accounts exploit string adjacency
- CCG: function application interspersed with composition and type raising (Steedman 1996)
- despite being weakly equivalent the CCG analysis of coordination cannot be imported into TAG
- TAGs need a treatment which is structural and not string based.

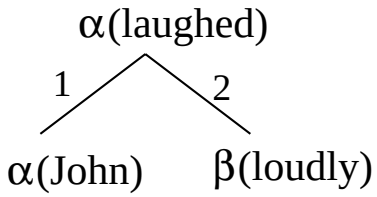
TAGs

TAG G:



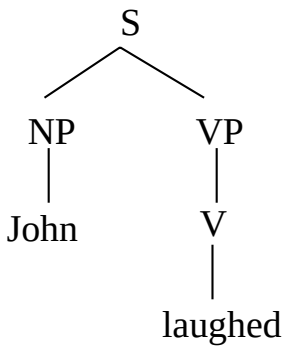


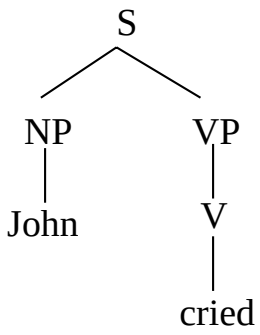
Derived Tree

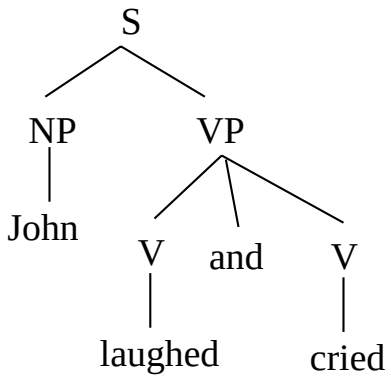


Derivation Tree

Coordination in a TAG: Problems





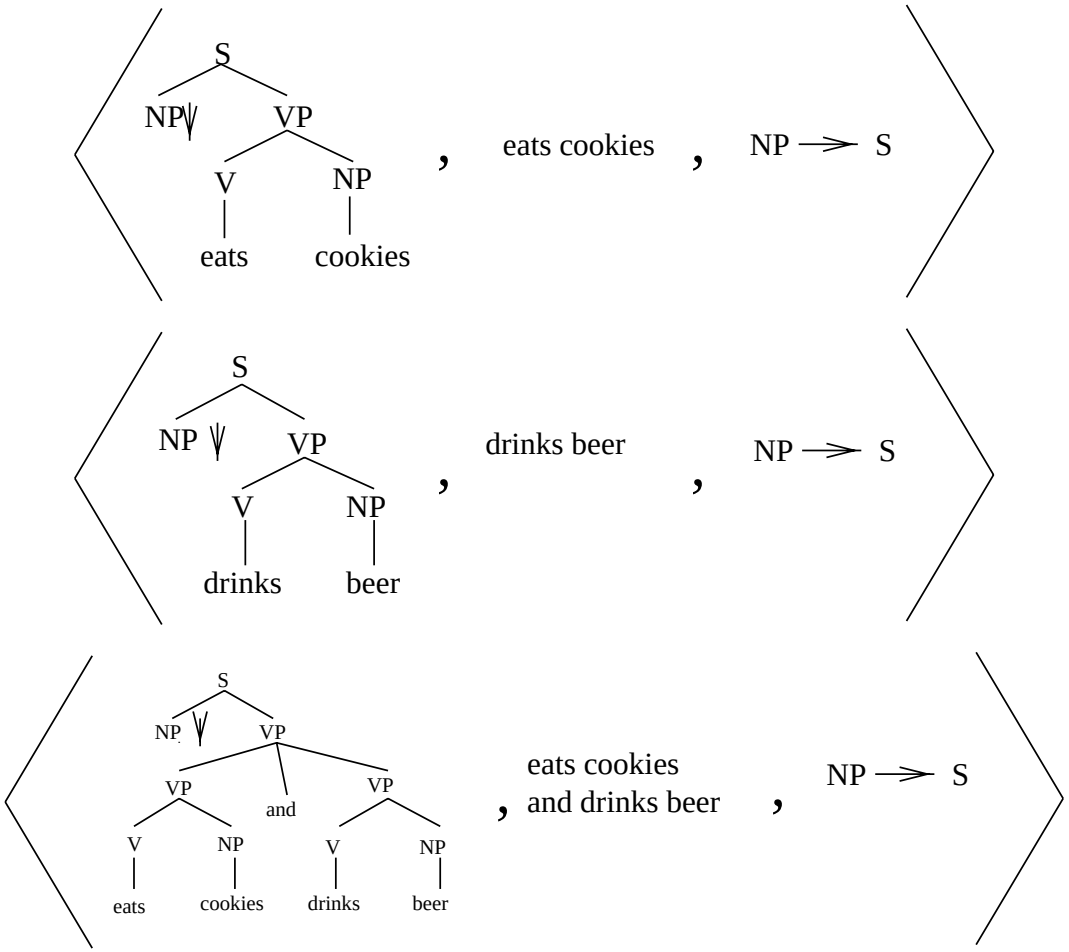


John laughed and cried

Motivation

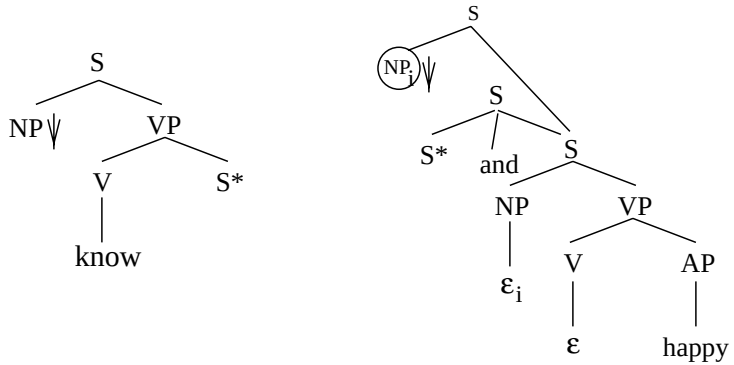
- TAG conflates the notion of dependency and constituency
- is it possible to separate constituent structure from dependency ?
- exploit notions from parallel rewriting systems to handle coordination (Engelfriet, Rozenberg and Slutzki, 1980)
- practical underpinnings: a parser for coordination
- ambiguity (multiple derivations) in non-coordinate sentences
- previous approaches in TAG give unsatisfactory consequences (Joshi and Schabes, 1991; Sarkar and Joshi, 1996)
- avoid structure merging in the parse or unrooted elementary trees

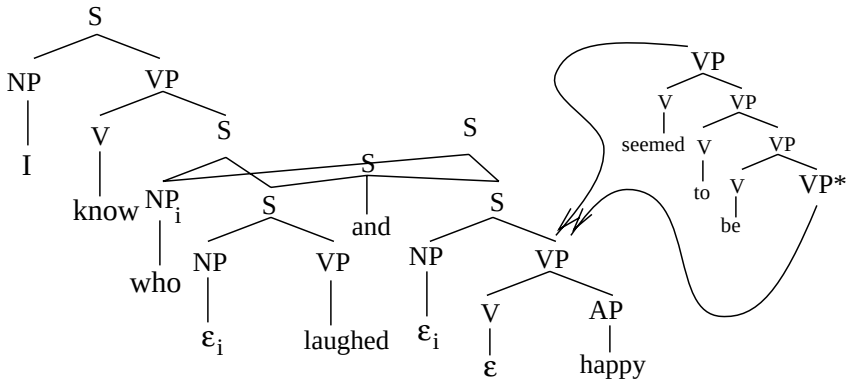
Structure Merging (Joshi and Schabes 91)



Coordination as Adjunction

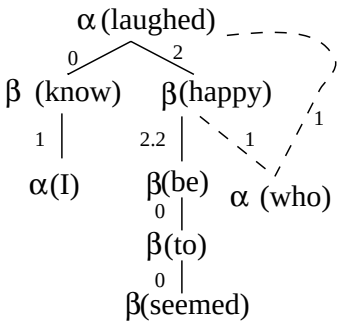
Elementary trees





I know who laughed and seemed to be happy

Derived structure

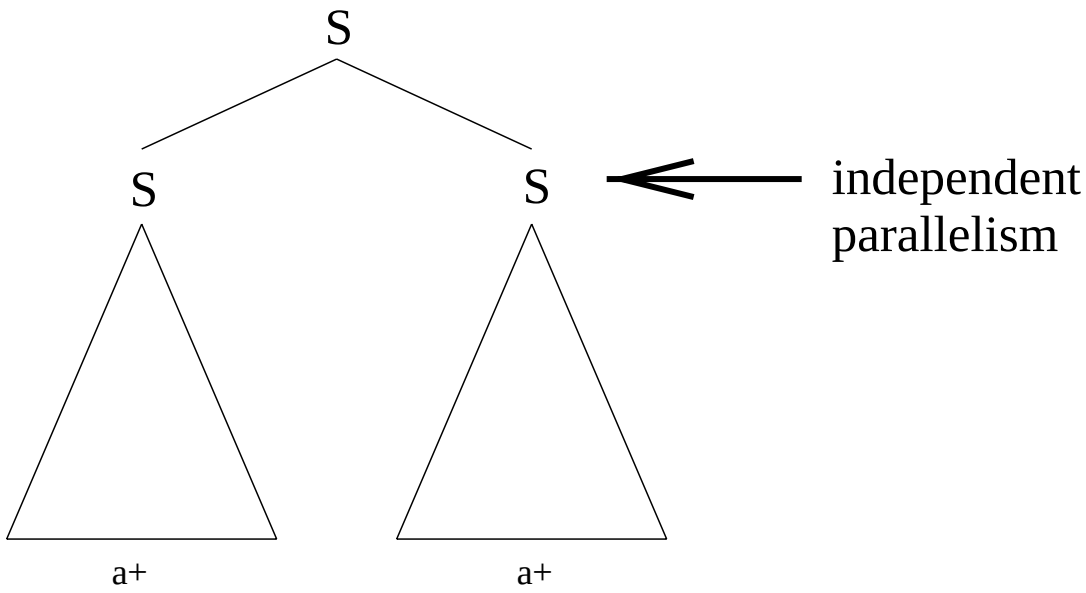


Derivation structure

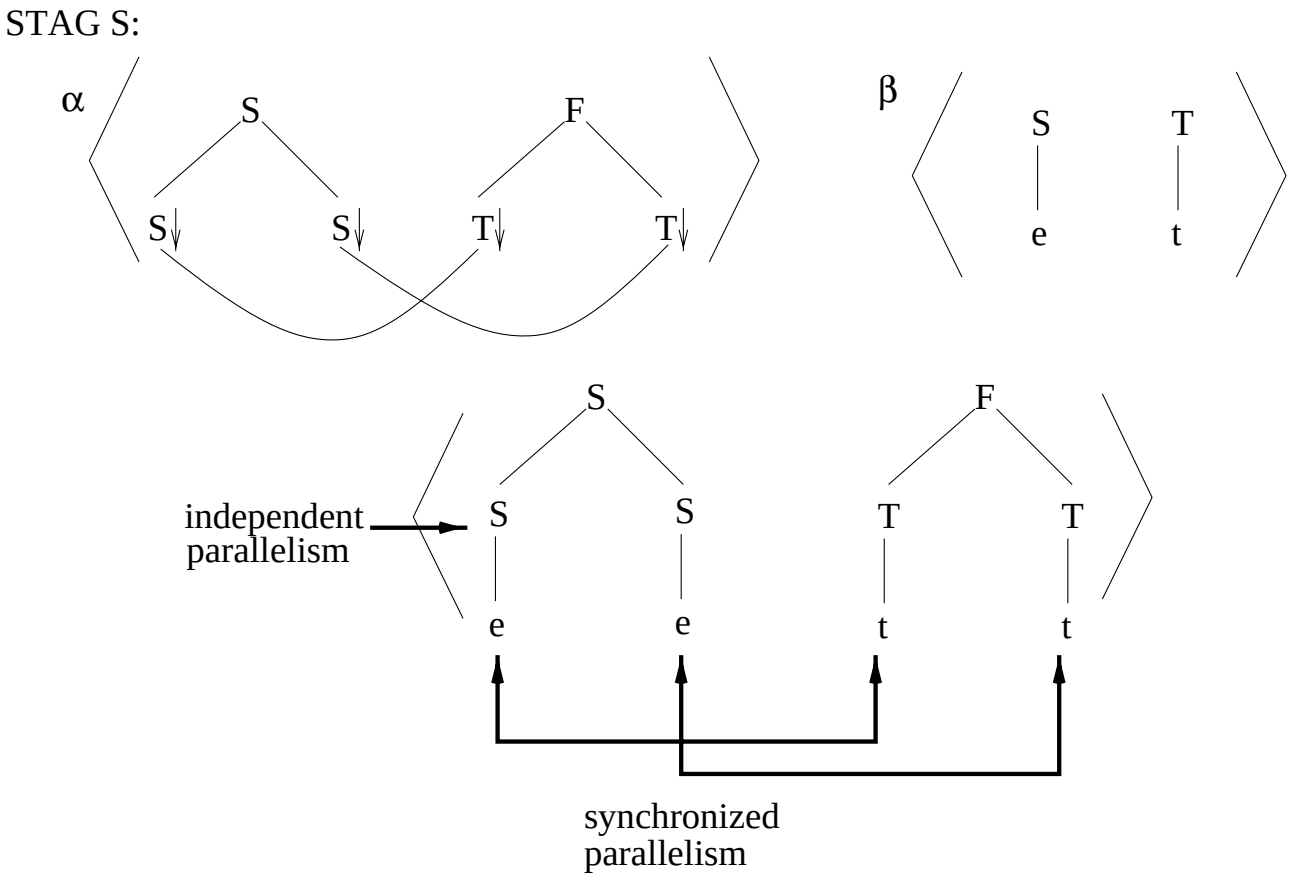
Independent Parallelism – CFGs

CFG G: S -> S S

S -> a

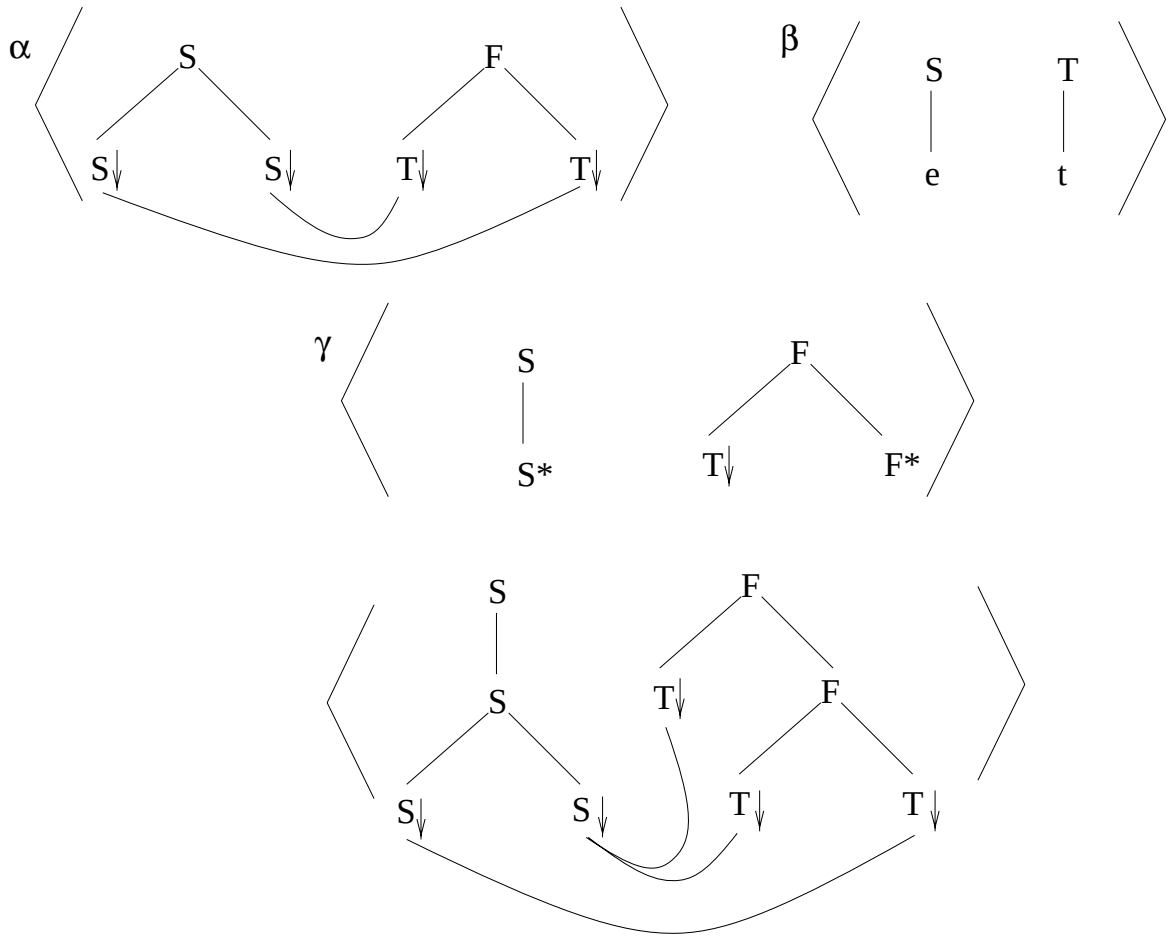


Synchronized Parallelism – STAGs

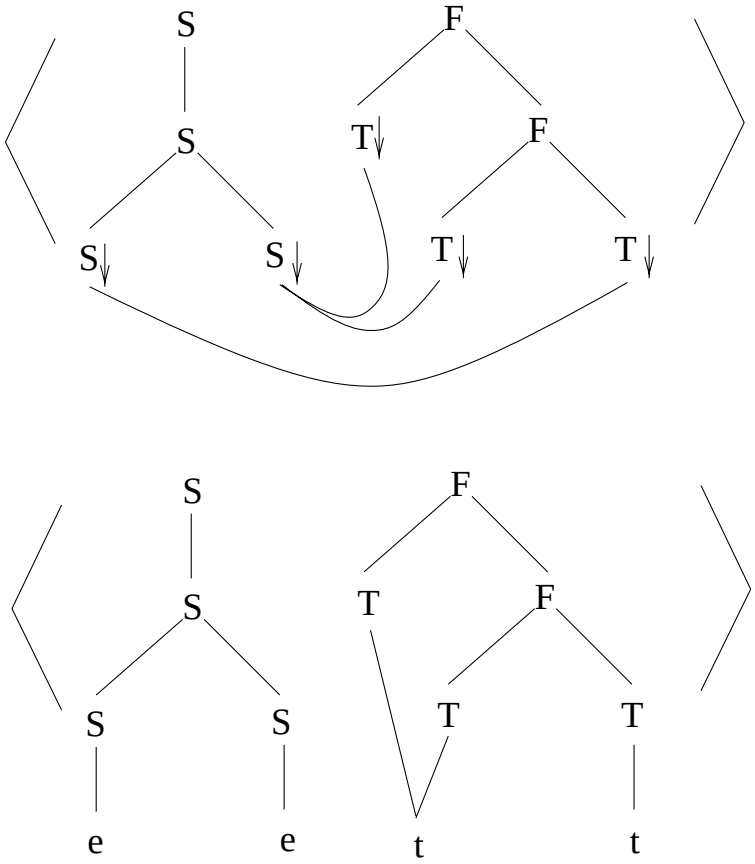


Non-local ‘sharing’ using Synchronized Parallelism

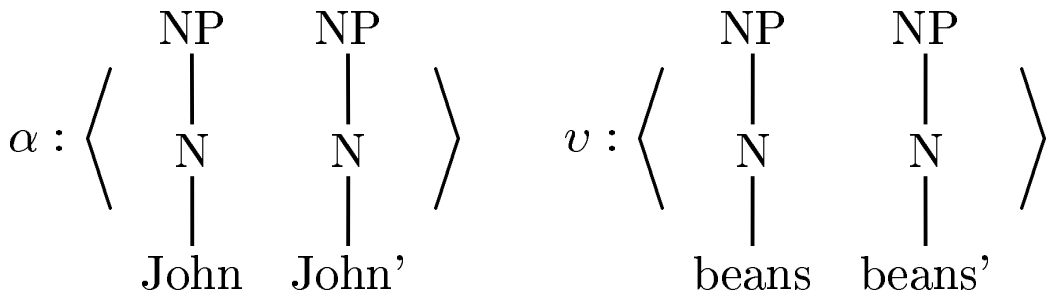
STAG S’:



Non-local ‘sharing’ using Synchronized Parallelism



LSTAG: by example



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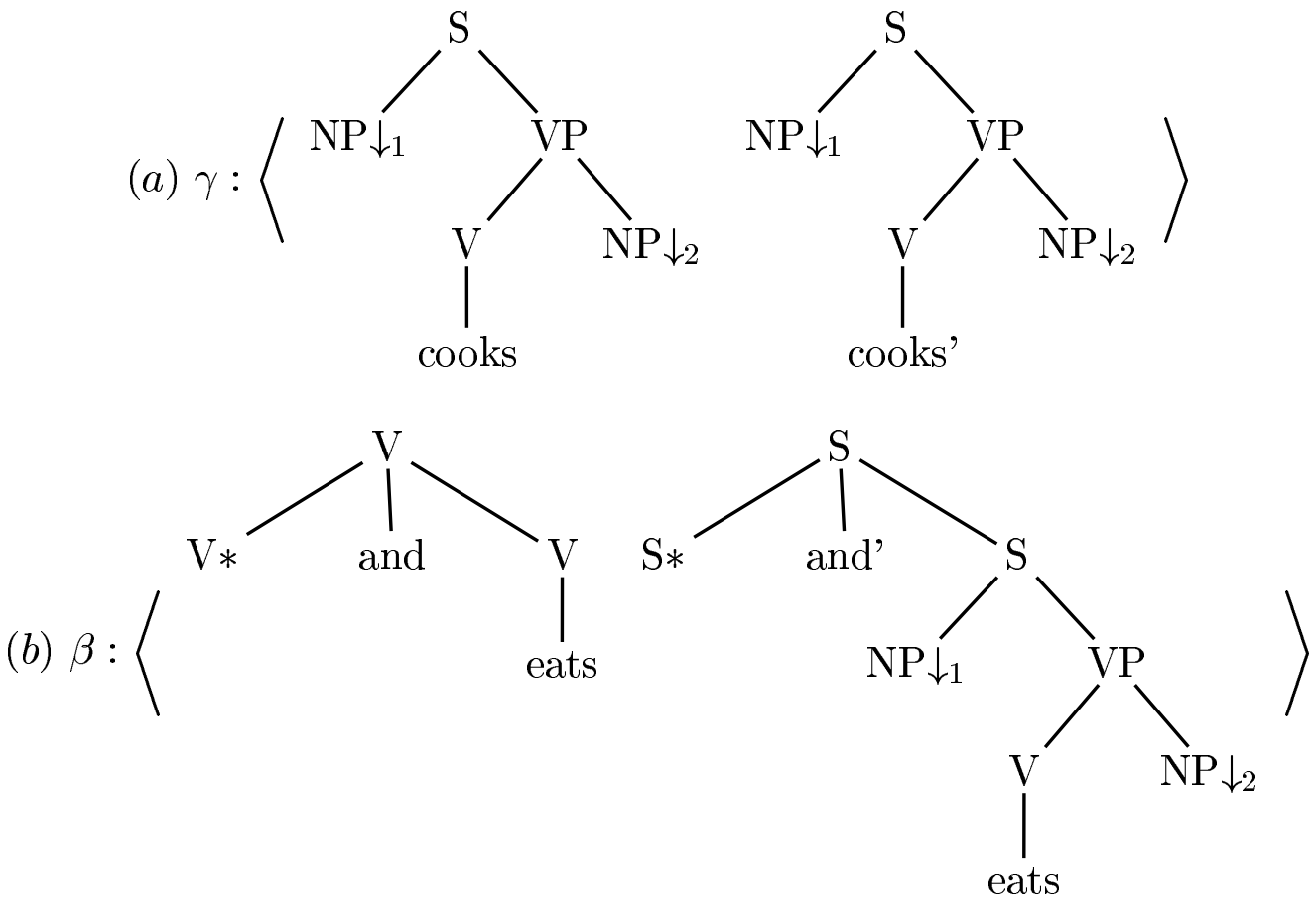
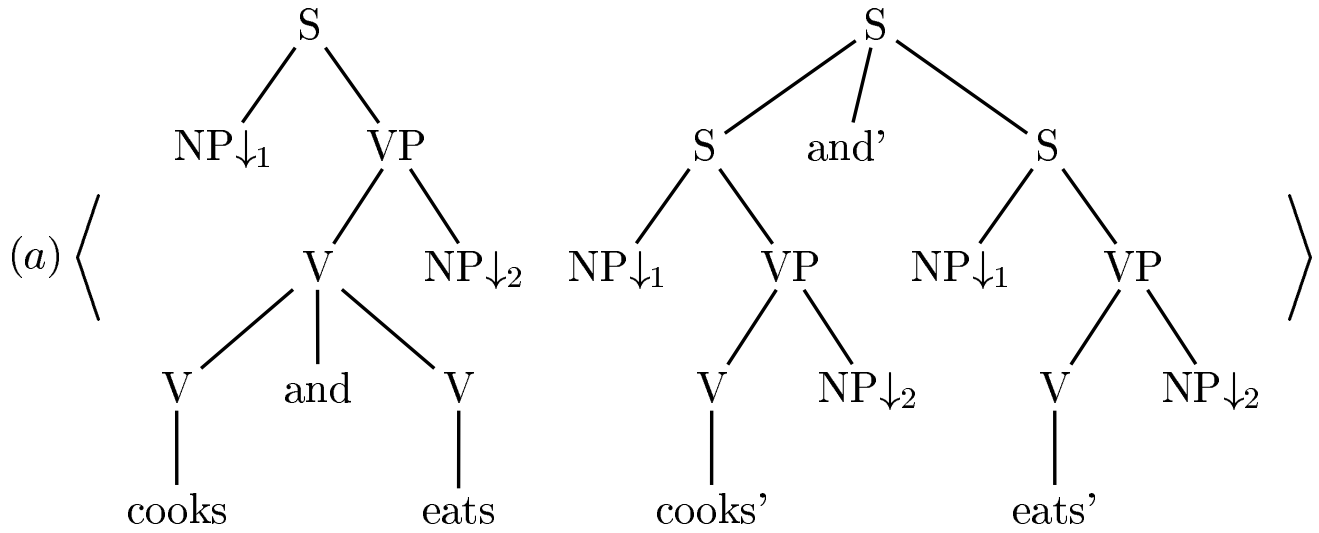
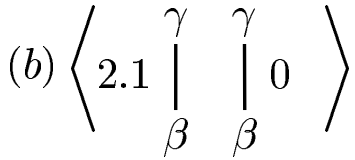
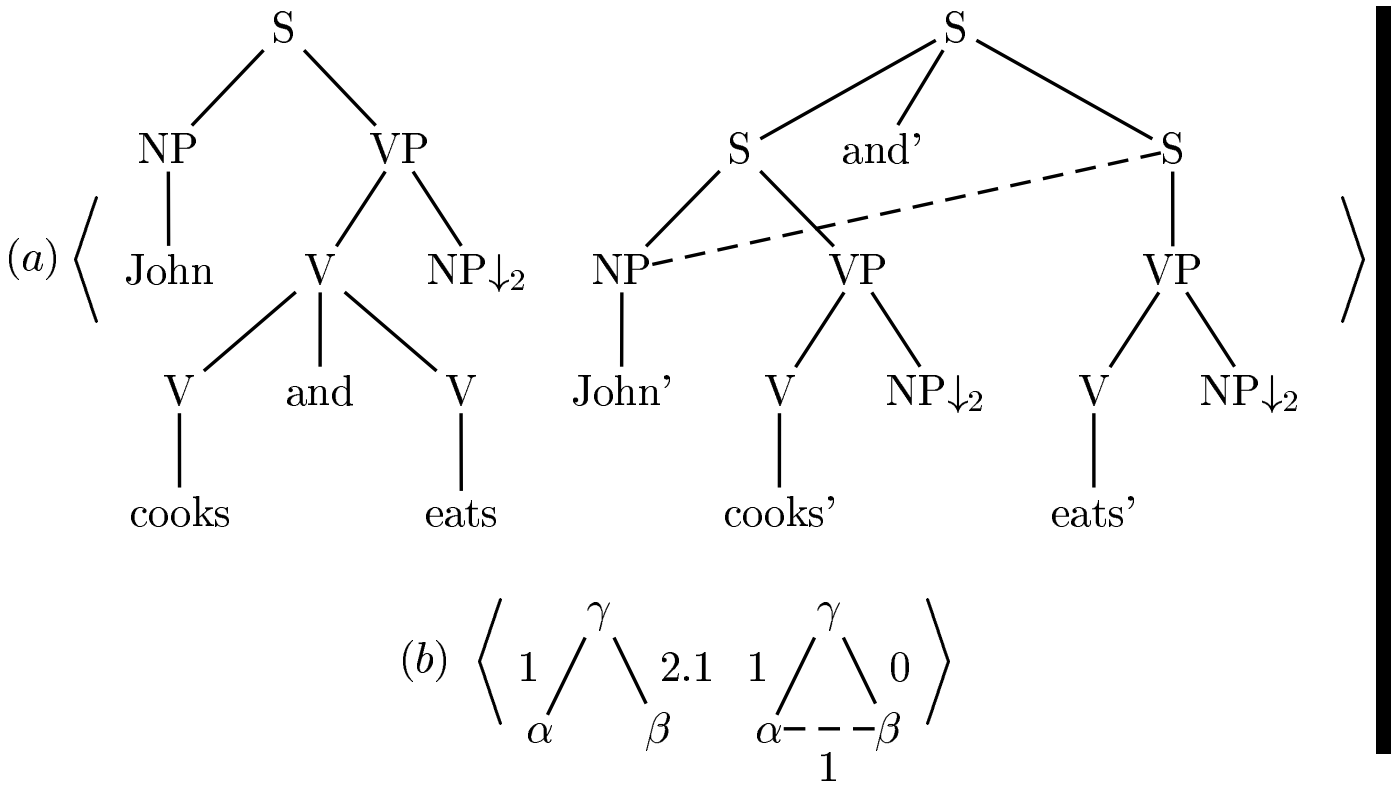


LSTAG: by example





LSTAG: by example



LSTAG: formal definition

An LSTAG G **is defined as a 4-tuple** $\langle G_L, G_R, \Delta, \Phi \rangle$ **where**

- G_L, G_R are standard TAGs,
- Δ and Φ are disjoint sets of sets of links and
- for each pair $\gamma = \langle \gamma_L, \gamma_R \rangle$, where $\gamma_L \in G_L$ and $\gamma_R \in G_R$,
- $\delta_\gamma \in \Delta$ is a subset of *links* in γ and
- $\phi_{\gamma_R} \in \Phi$ is a distinguished subset of *links*
- for each link $\frown \in \phi_{\gamma_R}$, $\eta \frown \eta$, where η is a node address in γ_R.
- δ_R and ϕ_{γ_R} have some canonical order $\prec$.

LSTAG: formal definition

- adjunction (similarly substitution) of $\langle \beta_L, \beta_R \rangle$ into γ is given by

$$\langle \gamma'_L, \gamma'_R \rangle = \langle \gamma_L[a_L, \beta_L], \gamma_R[a_R, \beta_R] \rangle$$

- $\langle \gamma'_L, \gamma'_R \rangle$ is the new derived structure with new set of links $\delta_\gamma \sqcup \phi_{\beta_R}$.
- *for all* $\frown_{\gamma_i} \in \delta_\gamma, \frown_{\beta_i} \in \phi_{\beta_R}, 1 \leq i \leq n$

$$\delta_\gamma \sqcup \phi_{\beta_R} \stackrel{def}{=} (\frown_{\gamma_1} \sqcup \frown_{\beta_1}) \cup \ldots \cup (\frown_{\gamma_n} \sqcup \frown_{\beta_n})$$

  where

$$(\frown_{\gamma_1} \prec \frown_{\gamma_2}), \ldots, (\frown_{\gamma_{n-1}} \prec \frown_{\gamma_n})$$

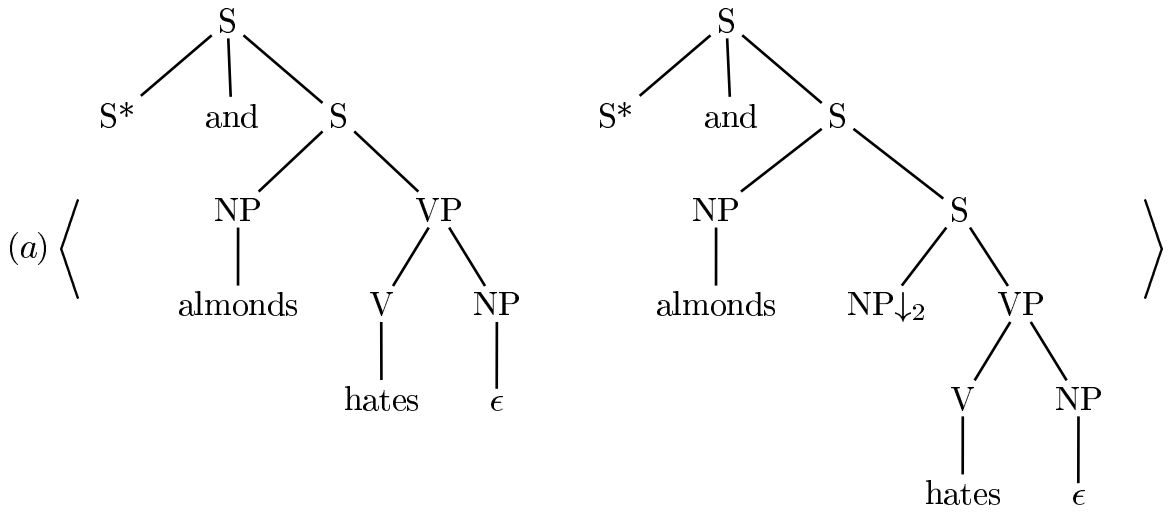
  and

$$(\frown_{\beta_{R_1}} \prec \frown_{\beta_{R_2}}), \ldots, (\frown_{\beta_{R_{n-1}}} \prec \frown_{\beta_{R_n}})$$

- $\frown_i \sqcup \frown_j$ is a set of links defined as follows. If $a_{L_i} \frown_i a_{R_i}$ and $a_{R_j} \frown_j a_{R_j}$, then

$$\frown_i \sqcup \frown_j \stackrel{def}{=} \{a_{L_i} \frown a_{R_i}\} \cup \{a_{L_i} \frown a_{R_j}\}$$

Restrictions



***Peanuts John likes and almonds hates.**

- these restrictions are not part of the formalism
- should be treated as well formedness conditions on elementary structures in the grammar
- they apply to NPs and not to Vs in English, for instance

Summary

- a structural approach towards coordination
- one which distinguishes linguistic dependency from the notion of constituency
- avoids structure merging in the parse and avoids unrooted elementary trees which were shortcomings of previous approaches
- extensions are formally better understood by using techniques from parallel rewriting systems
- the linguistic analyses presented in (Joshi and Schabes, 1991; Sarkar and Joshi, 1996) are easily adopted

Questions you can ask

- why are previous TAG approaches to coordination unsatisfactory ?
- does the approach cover more interesting cases of coordination ?
- can you handle gapping ?
- is this implemented ?

Practical underpinnings

- Xtag homepage:
  `http://www.cis.upenn.edu/~xtag`