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Separating Dependency from Constituency
in a Tree Rewriting System
Motivation

• TAGs need a treatment which is structural and not string based.

• Coordination cannot be imported into TAG despite being weakly equivalent the CCG analysis of composition and type raising (Steedman 1996)

• CCG: function application interspersed with composition and type raising

• Most successful accounts exploit string adjacency

• Distances dependency with coordination

• TAG: reconcile locality and endemically treatment of long
TAGs

TAG G:

\[ \alpha \text{(John)} \]

\[ \begin{array}{c}
\text{NP} \\
\text{N} \\
\text{John}
\end{array} \]

\[ \begin{array}{c}
\text{VP} \\
\text{V} \\
\text{laughed}
\end{array} \]

\[ \beta \text{(loudly)} \]

\[ \begin{array}{c}
\text{ADV} \\
\text{loudly}
\end{array} \]

Derived Tree

\[ \begin{array}{c}
\text{S} \\
\text{NP} \\
\text{N} \\
\text{John}
\end{array} \]

\[ \begin{array}{c}
\text{VP} \\
\text{ADV} \\
\text{loudly}
\end{array} \]

\[ \text{laughed} \]

Derivation Tree

\[ \begin{array}{c}
\text{VP*} \\
\text{ADV} \\
\text{loudly}
\end{array} \]

\[ \begin{array}{c}
\text{S} \\
\text{NP} \\
\text{N} \\
\text{John}
\end{array} \]

\[ \begin{array}{c}
\text{VP} \\
\text{ADV} \\
\text{loudly}
\end{array} \]

\[ \text{laughed} \]
Coordination in a TAG: Problems

John laughed

John cried

John laughed and cried
Motivation

Is it possible to separate constituent structure from dependency? TAC conflicts the notion of dependency and constituent structure.

Joshi, 1996

Consequences (Joshi and Schabes, 1991; Sarkar and Slutzki, 1980)

Multiple derivations in non-coordinate sentences

Ambiguity (multiple derivations) in non-coordinate sentences

Avoid structure merging in the parse or unrooted elementary trees

Exploit notions from parallel rewriting systems to handle coordination (Engelfriet, Rozemberg and Sturzaker, 1980)

Previous approaches in TAG give unsatisfactory practical underpinnings: a parser for coordination.

Previous approaches in TAG give unsatisfactory practical underpinnings: a parser for coordination.

Avoid structure merging in the parse or unrooted elementary trees
Structure Merging (Joshi and Schabes 91)

S
  NP
    VP
      V
        eats
          cookies

S
  NP
    VP
      V
        drinks
          beer

S
  NP
    VP
      and
        eats cookies
      VP
        and
          drinks beer
Coordination as Adjunction

Elementary trees

1. S
   NP
   VP
   know

2. S
   S*
   NP
   VP
   know

3. S
   S
   and
   S*
   NP
   VP
   ε
   ε
   happy

4. S
   NP
   VP
   ε
   ε
   laughed

I know who laughed and seemed to be happy

Derived structure

α (laughed)

β (know)

β (happy)

α (I)

β (be)

α (who)

β (seemed)

Derivation structure
Independent Parallelism – CFGs

CFG $G$: $S \rightarrow S \ S$

$S \rightarrow a$

[Diagram of a tree structure with nodes labeled $S$, $a+$, and independent parallelism]
Synchronized Parallelism – STAGs

STAG S:

\[ \alpha \] \hskip 1cm \langle S \rangle \hskip 1cm \langle F \rangle \\
\langle S \downarrow \rangle \hskip 0.2cm \langle S \downarrow \rangle \hskip 0.2cm \langle T \downarrow \rangle \hskip 0.2cm \langle T \downarrow \rangle \\
\beta \hskip 1cm \langle S \rangle \hskip 1cm \langle T \rangle \\
\langle e \rangle \hskip 0.2cm \langle t \rangle \\
\hskip 1cm \langle e \rangle \hskip 0.2cm \langle e \rangle \hskip 0.2cm \langle t \rangle \hskip 0.2cm \langle t \rangle \\

independent parallelism

synchronized parallelism
Non-local ‘sharing’ using Synchronized Parallelism
Non-local ‘sharing’ using Synchronized Parallelism
John, John, beans, beans,

\[
\begin{array}{c}
\text{LSTAG: by example} \\
\end{array}
\]
LSTAG: by example
An LSTAG is defined as a 4-tuple \((\Phi, G_L, G_R, \nabla)\) where: 

- \(\forall R \in G_R\) and \(\forall L \in G_L\) have some canonical order. 
- \(\forall R \in G_R\) and \(\forall L \in G_L\) where \(u \sim u\), where \(u\) is a node. 
- For each link \(\mathcal{L} \in \Phi \in \nabla\) is a distinguished subset of links. 
- \(\forall \phi \in \Phi\) is a subset of links in \(\nabla\) and \(\forall R \in G_R\) is a node in \(\nabla\). 
- \(\forall \phi \in \Phi\) is a subset of links in \(\nabla\) and \(\forall R \in G_R\) is a node in \(\nabla\). 
- For each pair \(\forall (\mathcal{L}, \mathcal{R}) \in \nabla\), where \(\forall L \in G_L\) and \(\forall R \in G_R\) are disjoint sets of links. 
- An LSTAG \(G\) is defined as a 4-tuple \((\Phi, G_L, G_R, \nabla)\) where:

In LSTAGs, formal definition...
Given by adjunction (similarity substitution) of \( \langle R, \ell \rangle \) into is similarly defined.
Restrictions

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

Peanuts John likes and almonds hates.

\[ e \rightarrow S, V, \ldots \]

\[ d \rightarrow N, A, \ldots \]

\[ S \rightarrow Np \]

\[ N \rightarrow Np \]

\[ V \rightarrow \ldots \]

\[ A \rightarrow \ldots \]

\[ \text{and} \]

\[ \text{hates} \]

\[ \text{almonds} \]

\[ (a) \]
a structural approach towards coordination on which distinguishes linguistic dependency from the notion of constituency and avoids structure merging in the parse and avoids the linguistic analyses presented in (Joshi and Schabes, 1991; Sarkar and Joshi, 1996) are easily adopted extensions are formally better understood by using techniques from parallel rewriting systems previous approaches avoid structure merging in the parse and avoids 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 unsatisfactory?
- Do these approaches cover more interesting cases of coordination?
- Can you handle gapping?
- Is this implemented?
- Does the approach cover more interesting cases of coordination?
- Why are previous TAG approaches to coordination unsatisfactory?

Practical underpinnings:

XTAG homepage: http://www.cis.upenn.edu/~xtag