

Lec18: Other syntactic representations

Slides from S.Husain

HUL 242

7/4

Other grammar formalisms

- Dependency grammar
- Tree adjoining grammar

Overgeneration of CFGs

the man slept
the park slept
the dog slept
a man slept
a park slept
a dog slept

Theta grid

[John_i] placed [the flute_j] [on the table_k]

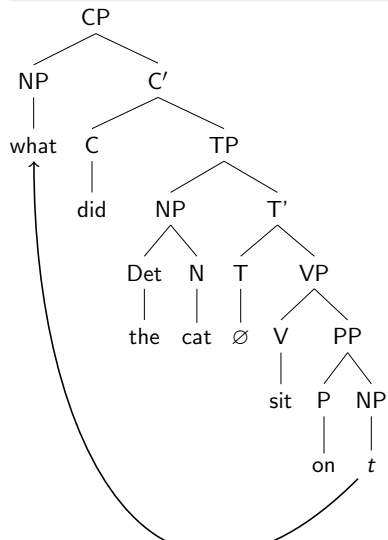
place		
Agent	Theme	Goal
DP	DP	PP
i	j	k

CFGs alone inadequate

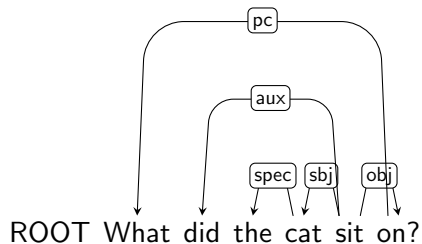
- Representing lexical properties (e.g. verb subcategorization)
- Very useful as a formal method to generate sets of strings
- Need to go beyond CFG, done via transformations, parallel representations or extensions of CFG itself

Long distance dependencies

[CP [NP What] [C did [TP the cat \emptyset sit on t]] ?



Dependency solution ?



Some rewrite rules

$S \rightarrow NP VP$

$VP \rightarrow V NP$

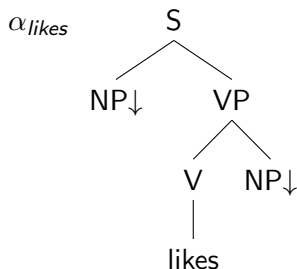
John likes Lyn

We substitute rewrite rules with tree rewrite rules

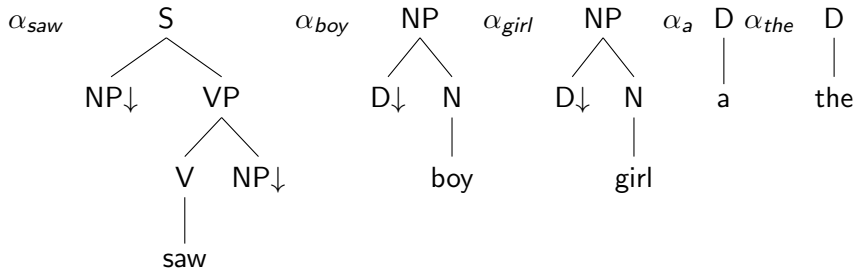
We lexicalize the grammar

Expand the rewrite rules

- Instead of a single level rewrite, there is a tree rewrite
 - ▶ This helps capture linguistic constraints
 - ▶ Also helps expand the domain of locality
- $S \rightarrow NP VP$; $VP \rightarrow V NP$
- $S \rightarrow NP \text{ likes } NP$



Tree fragment rewrites



Tree substitution grammar

- Consists of initial trees and substitution operation
- Initial trees
 - ▶ Nodes labeled by non-terminal and terminal symbols
 - ▶ All leaf nodes labeled with either terminal or non-terminals
 - ★ Such non-terminals nodes are called substitution nodes, represented by down arrow
- When every initial tree has at least one terminal symbol, the grammar becomes lexicalized tree substitution grammar

Lexicalized grammars

A grammar is lexicalized if

- every finite structure of the grammar is associated with one or more lexical items (called anchors which must be realized overtly)
- There are one or more operations for composing the structure

Substitution

- Derived tree: a tree obtained by sequence of substitution operation
- A tree is called 'completed' if all its leaf nodes are labeled by terminal symbols

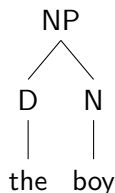
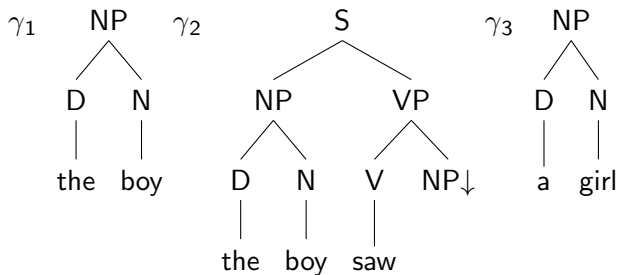


Figure: Derived tree after substituting α_{the} in α_{boy}

Substitution

the boy saw a girl



Substitution

the boy saw a girl

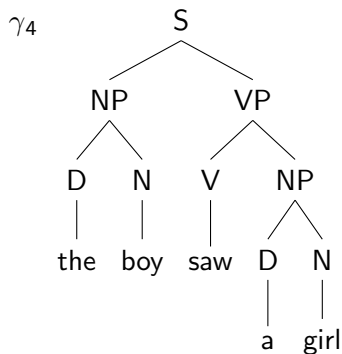


Figure: Derived tree γ_4 for 'the boy saw a girl'

Derivation tree

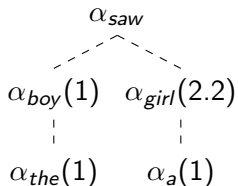


Figure: Derivation tree showing all the substitutions that lead to γ_4 . Dashed edges represent substitution operation.

Tree adjoining grammar

- TSG are not powerful enough to capture certain kinds of constructions (eg. wh-construction in English)
 - ▶ Recall that we needed transformation rules in order to capture such constructions while using phrase structure rules
- In order to capture such phenomenon, we augment TSG with new structures and operations. This grammar is called TAG

Tree adjoining grammar

- Structures: Initial trees and Auxiliary trees
- Operations: Substitution and Adjoining

Auxiliary tree

- leaf nodes labeled by terminal symbols and non-terminal symbols
 - exactly one leaf non-terminal node (called as foot node) same as the root of the auxiliary tree
 - and all other non-terminal nodes are substitution nodes
- If every auxiliary tree (besides initial tree) has at least one lexical anchor, then such a grammar is called lexicalized tree adjoining grammar.

Adjoining operation

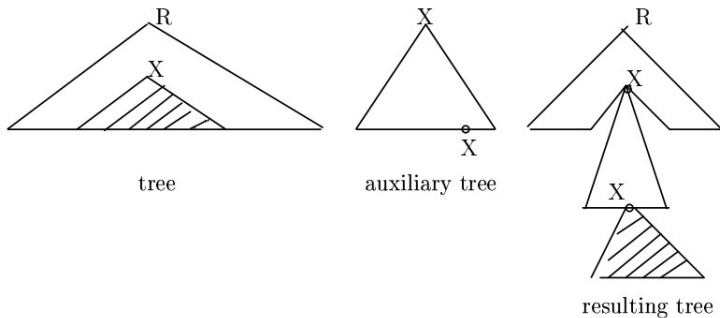
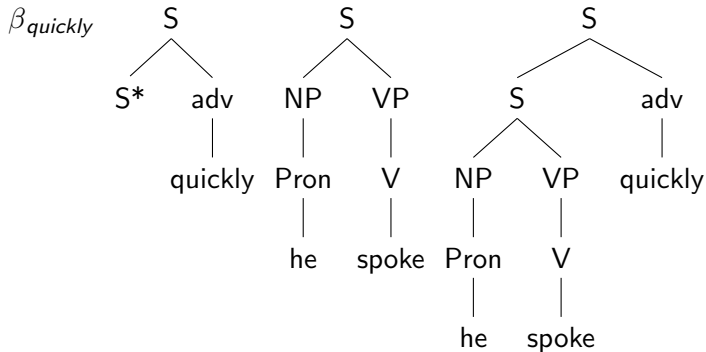


Figure: Adjoining operation

Adjoining operation: Handling adverbials



Adjoining operation: Handling wh

who did he call?

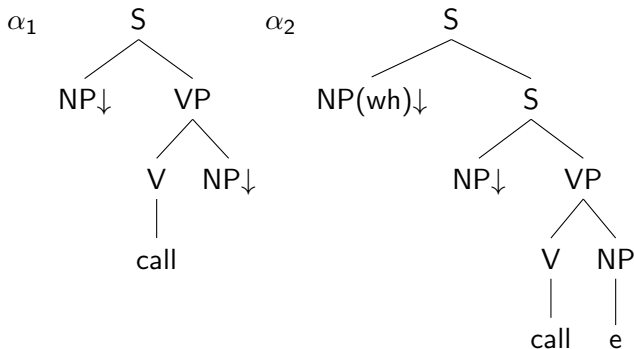
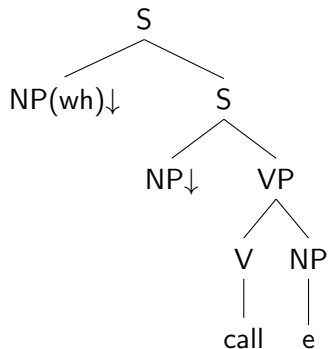


Figure: Elementary tree for 'call'. α_1 : transitive, α_2 : object extraction

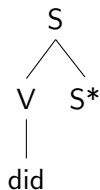
Adjoining operation: Handling wh

who did he call?

α_2



β_1



Derivation tree

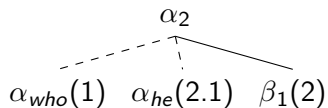


Figure: Derivation tree showing all the operations to derive '*who did he call*'. Dashed edges represent substitution operation, solid edges represent adjoining.

Wrapping up

- L-TAG belongs to a family of grammars that are termed as mildly context sensitive grammars
- has desirable properties like lexicalization, extended domain of locality (eg. agreement, subcategorization, filler-gap dependency)
- polynomial parsing complexity, $O(n^7)$