Toward Tree Substitution Grammars with Latent Annotations

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Motivation

- Treebanks are coarse in multiple dimensions
- Complementary solutions have been proposed
  - Latent annotations (symbol refinements)
  - Tree substitution grammars
- Can we combine these approaches?

Learning Latent Annotations

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PRP

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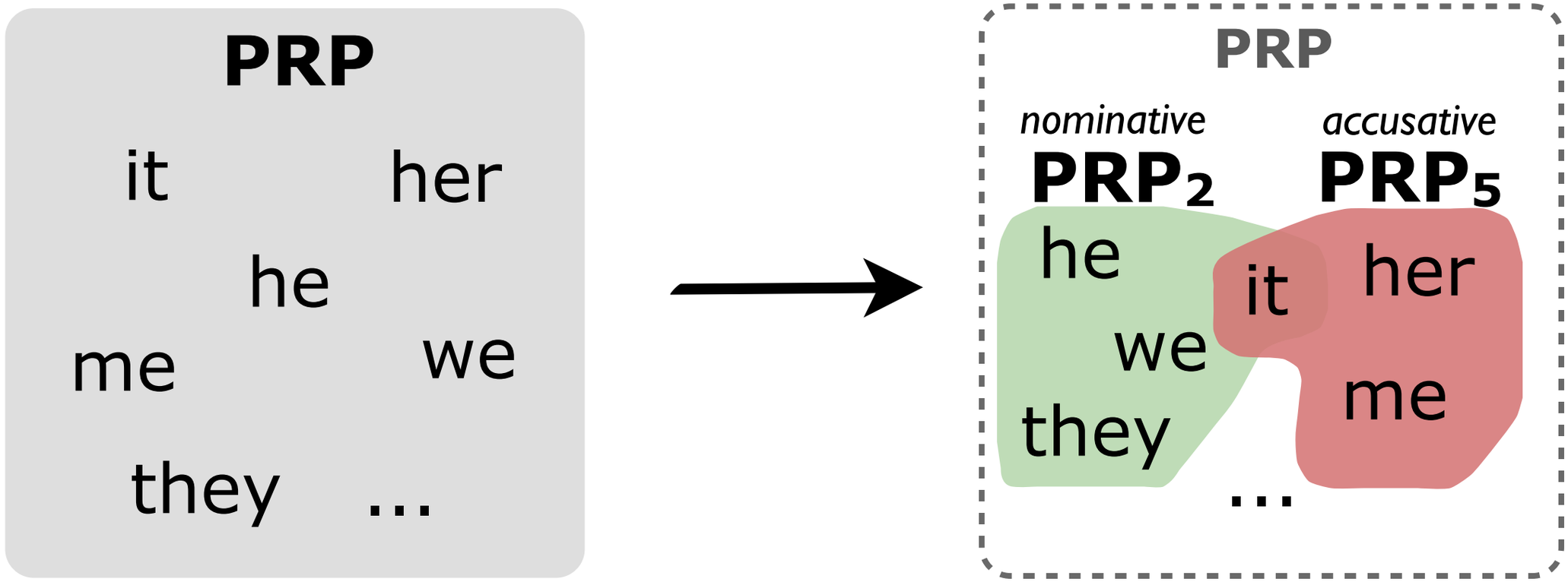
he

me we

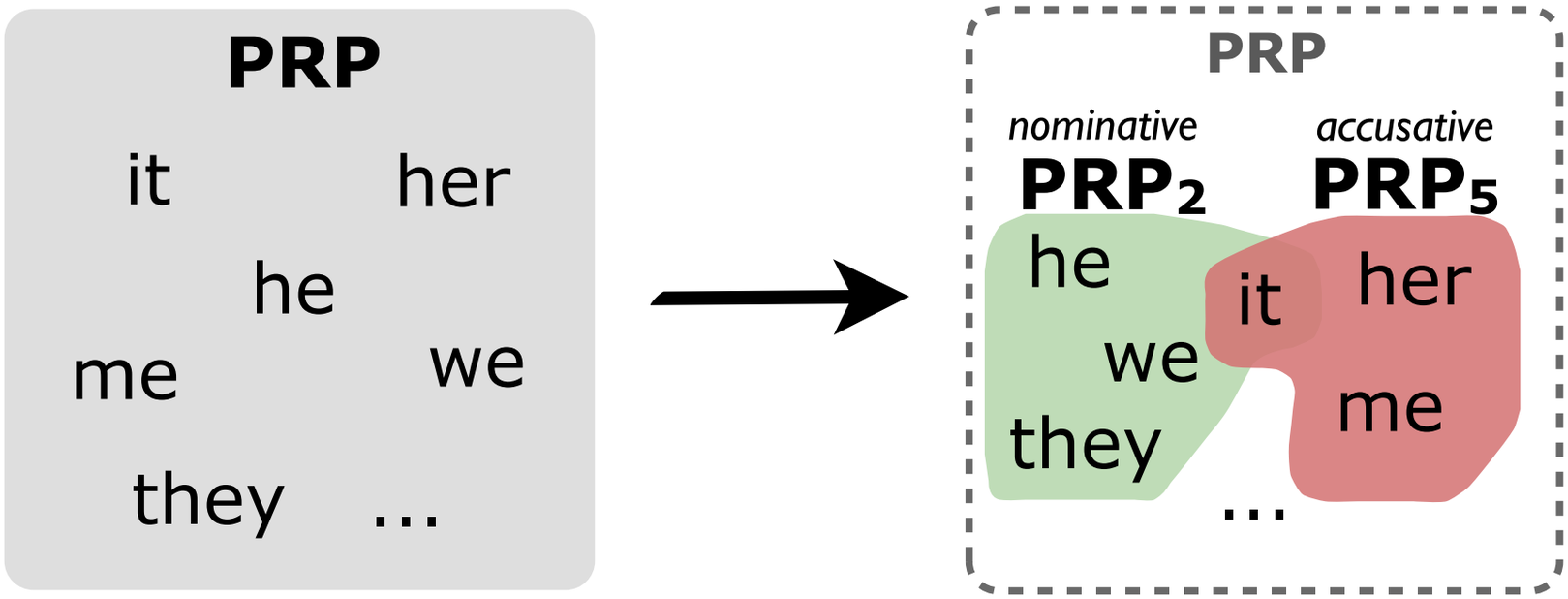
they ...

Learning Latent Annotations



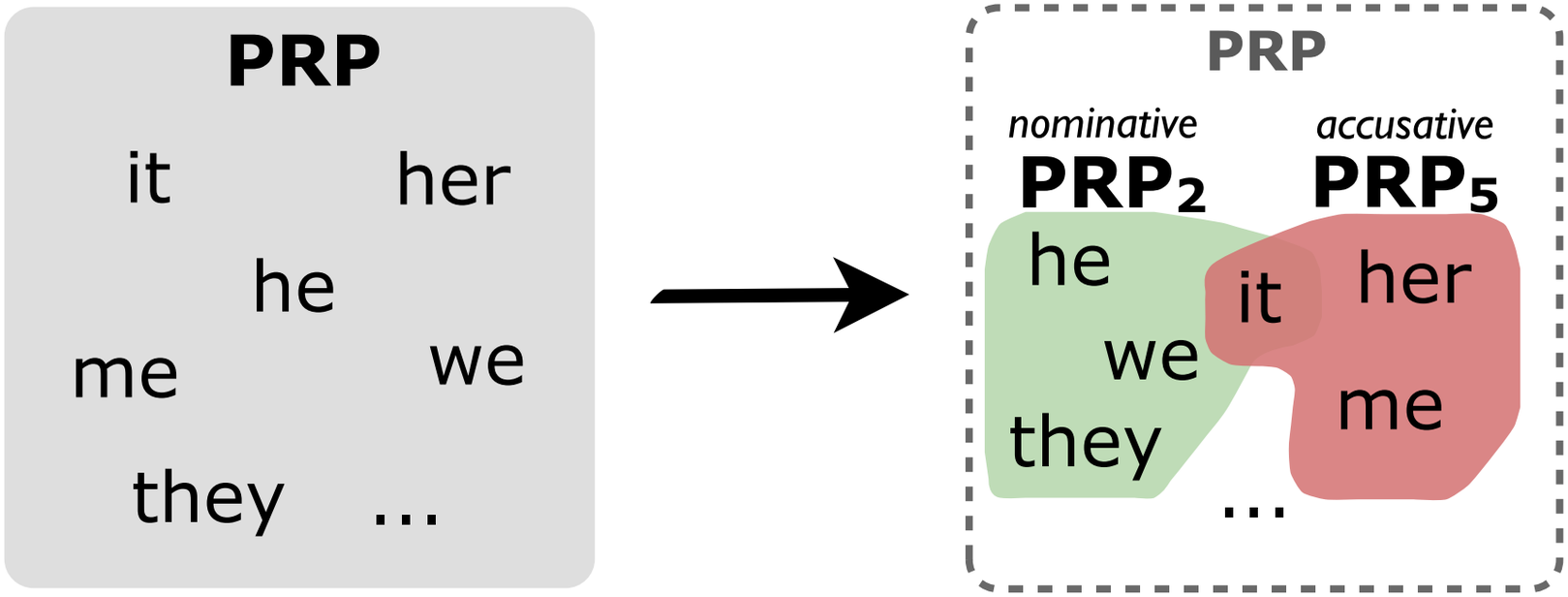
Learning Latent Annotations

- Can we compensate for PCFG permissiveness?
- Johnson (1998): parent annotation
- Klein and Manning (2003): linguistically motivated annotations

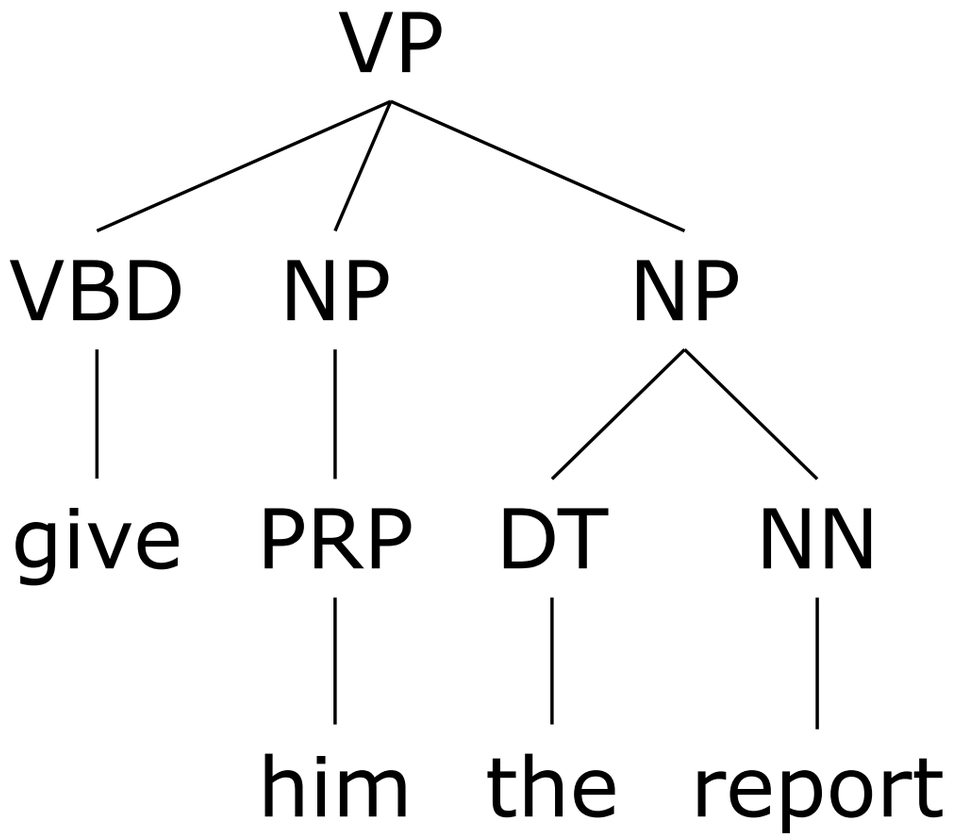


Learning Latent Annotations

- Can we learn them automatically?
- Split all categories equally and learn weights via EM (Matsuzaki et al., 2005)
- Iteratively improve refinements: "split-merge" framework (Petrov et al., 2006)
- Intuitive lexical clusterings



Tree Substitution Grammars



Tree Substitution Grammars

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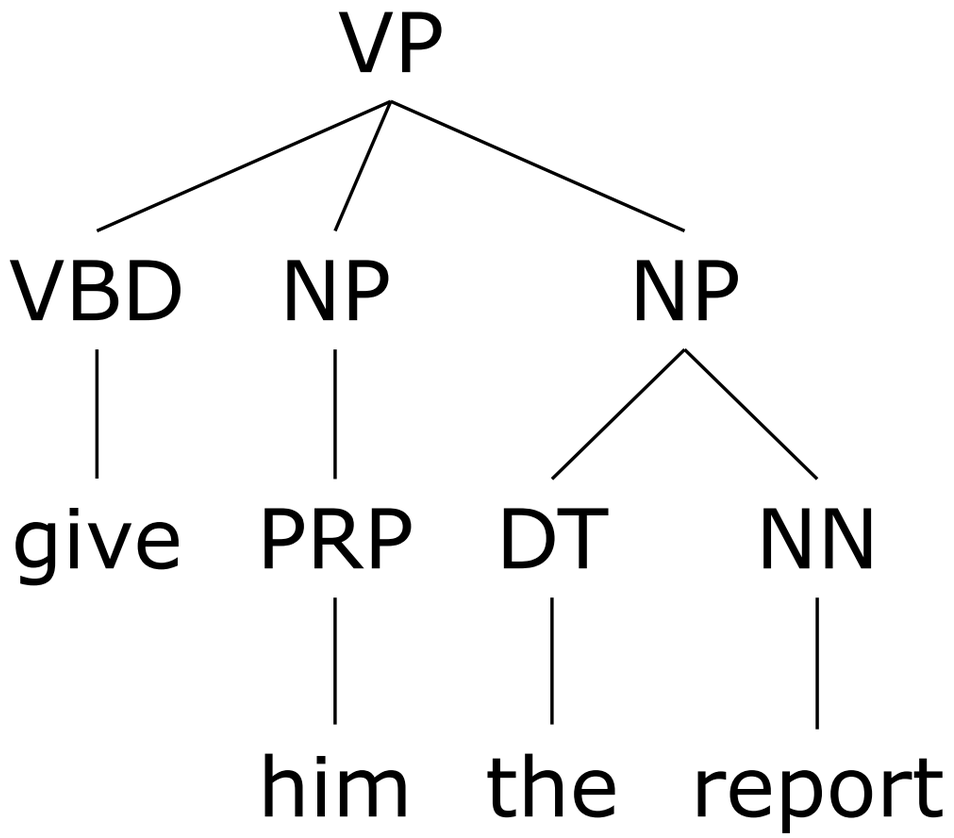

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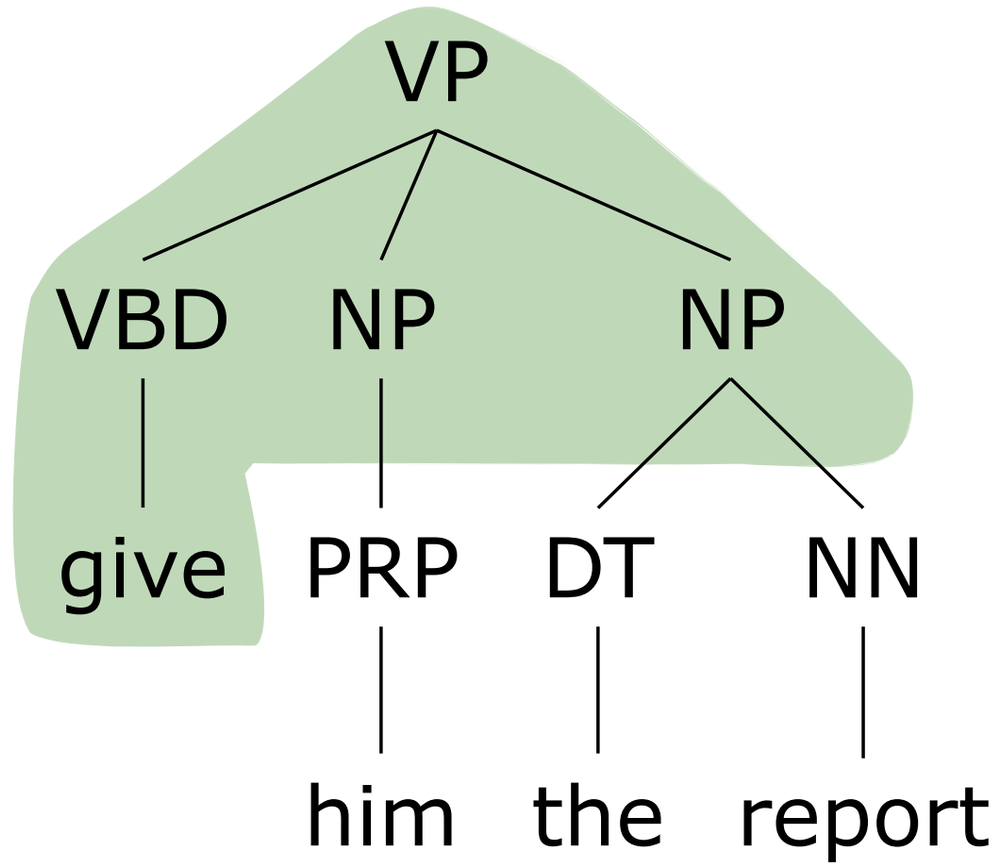
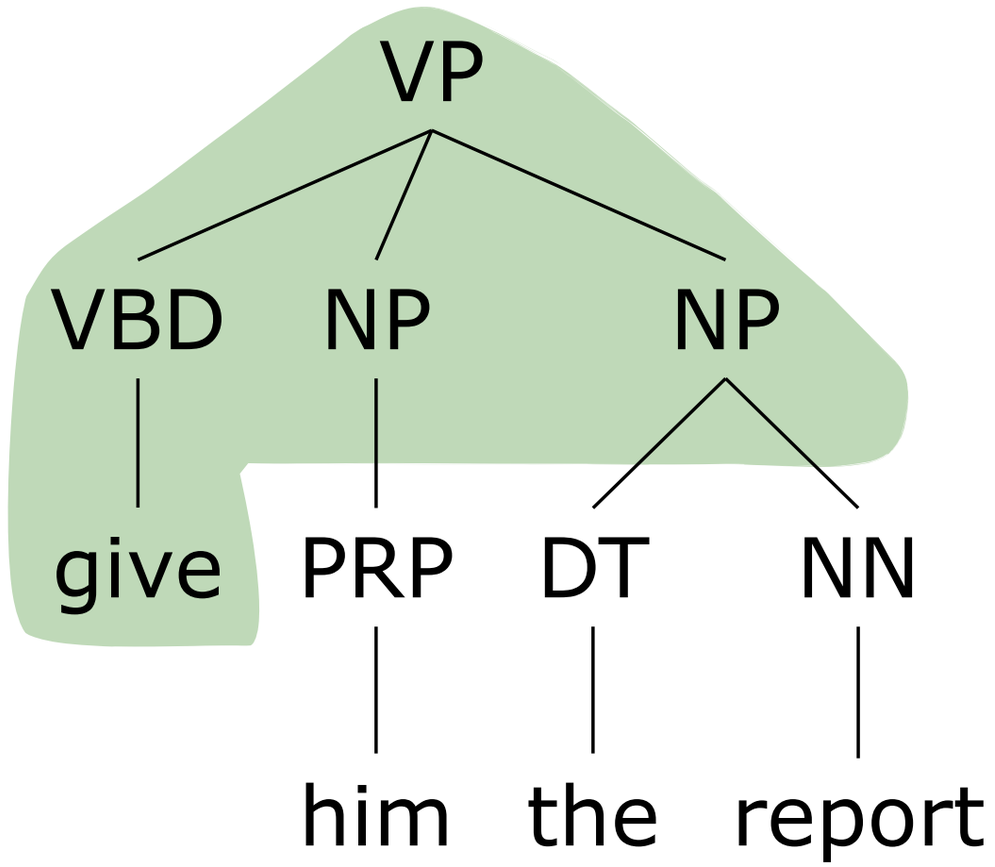


Tree Substitution Grammars

- Non-terminals rewrite as tree fragments
- Extended domain of locality
- Capture long-range grammatical dependencies



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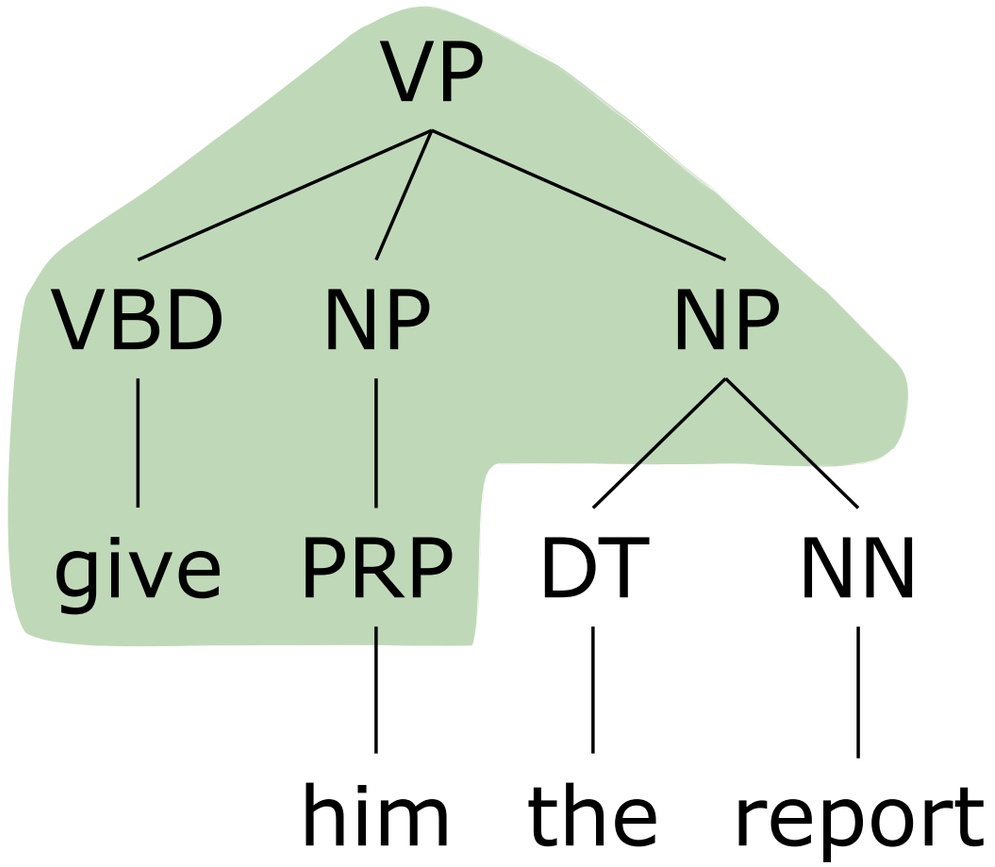

Tree Substitution Grammars

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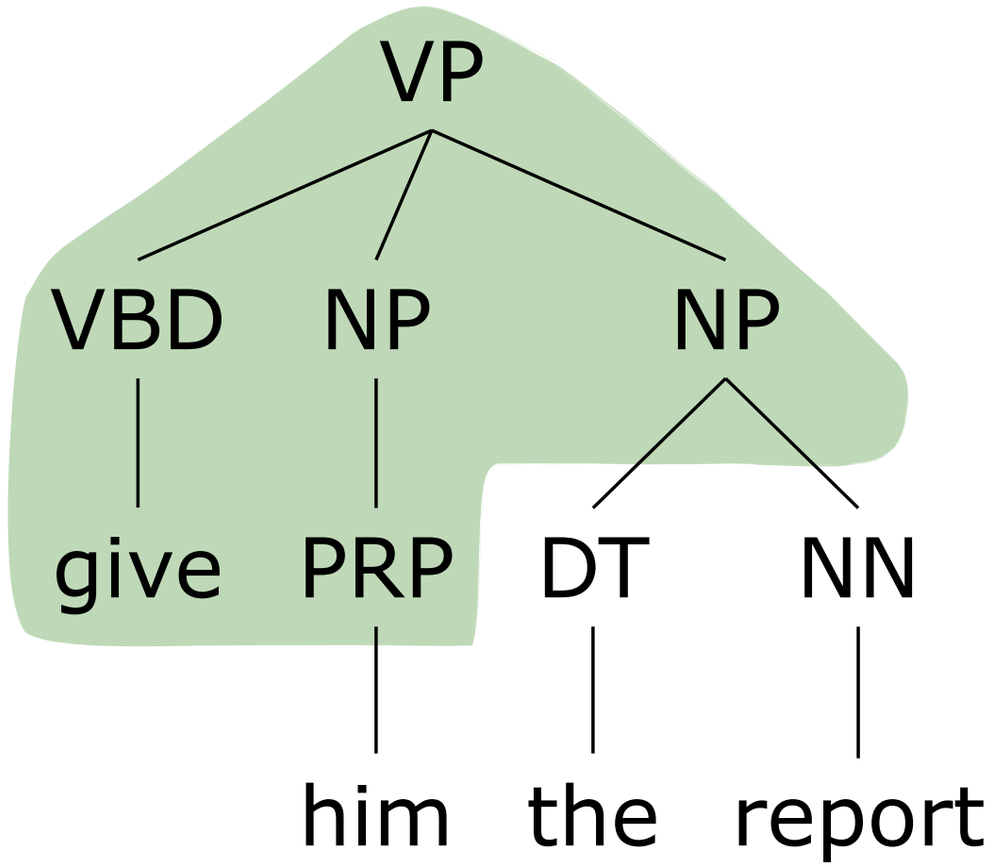
- DOP: All fragments (Bod, 1993)

  ✗ Even with heuristic selection, get large, over-fit grammars (Bod, 2001)



Tree Substitution Grammars

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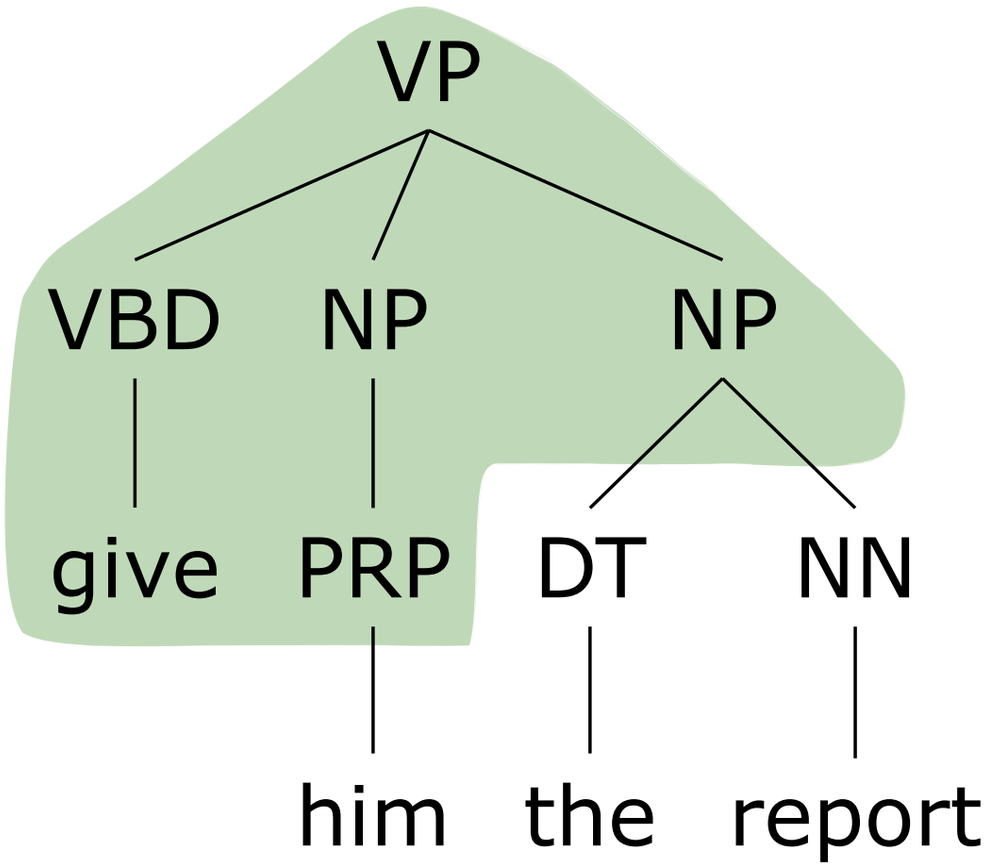
  - ✗ Even with heuristic selection, get large, over-fit grammars (Bod, 2001)
- Non-parametric: DP Prior (Cohn et al., 2009; Post et al., 2009)
  - ✓ Compact fragments
  - ✗ Non-deterministic
  - ✗ Complex to implement.



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- Build within the Berkeley parser codebase
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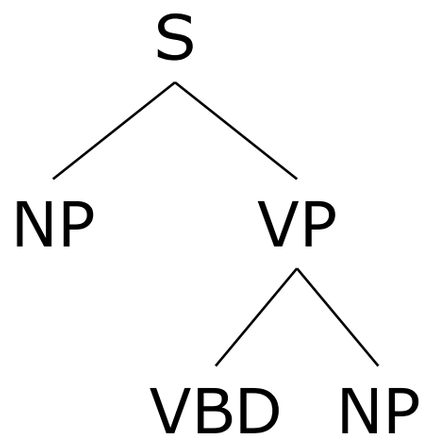

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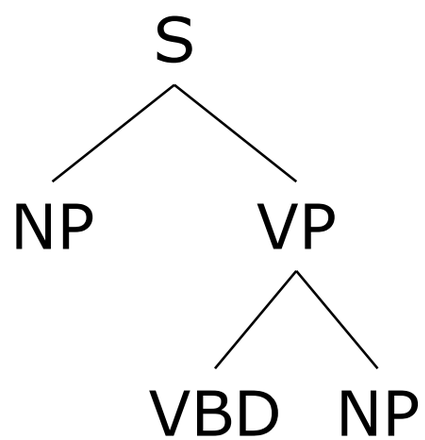

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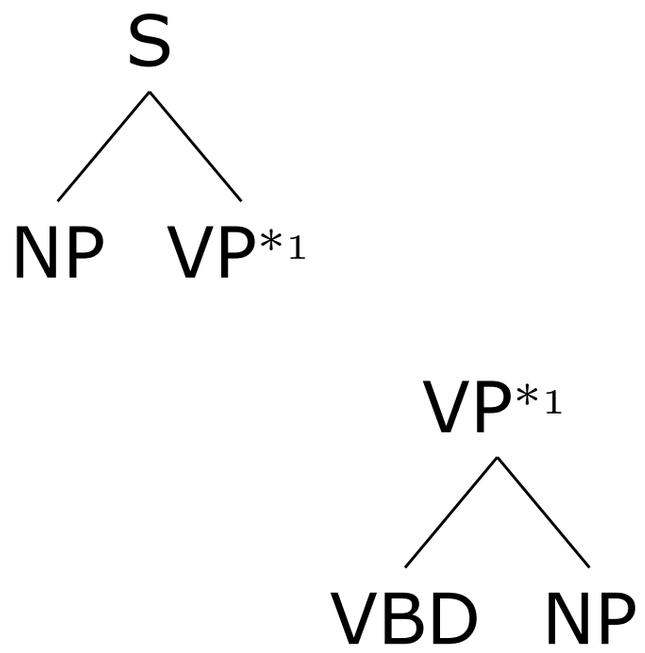

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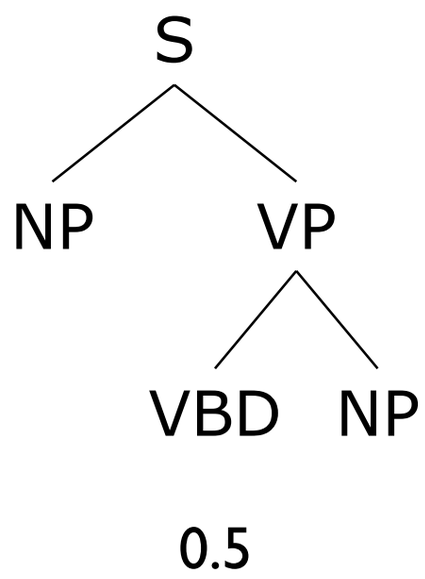

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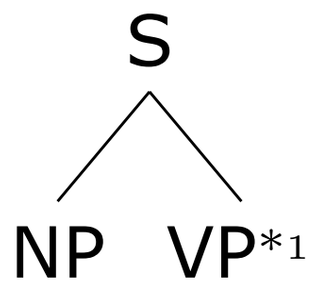

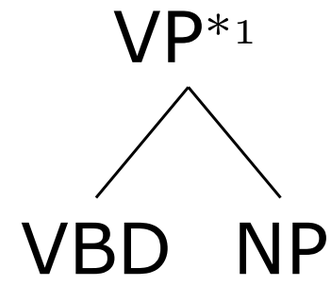

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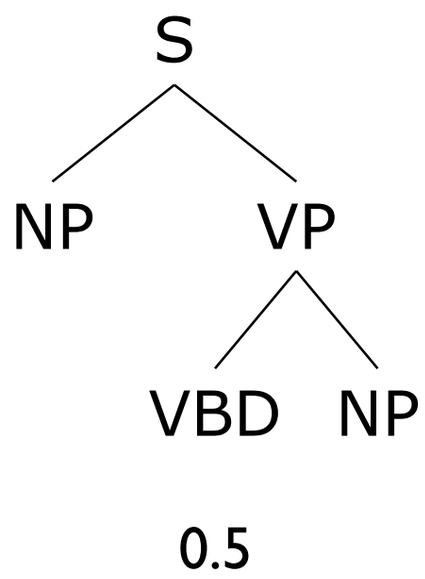
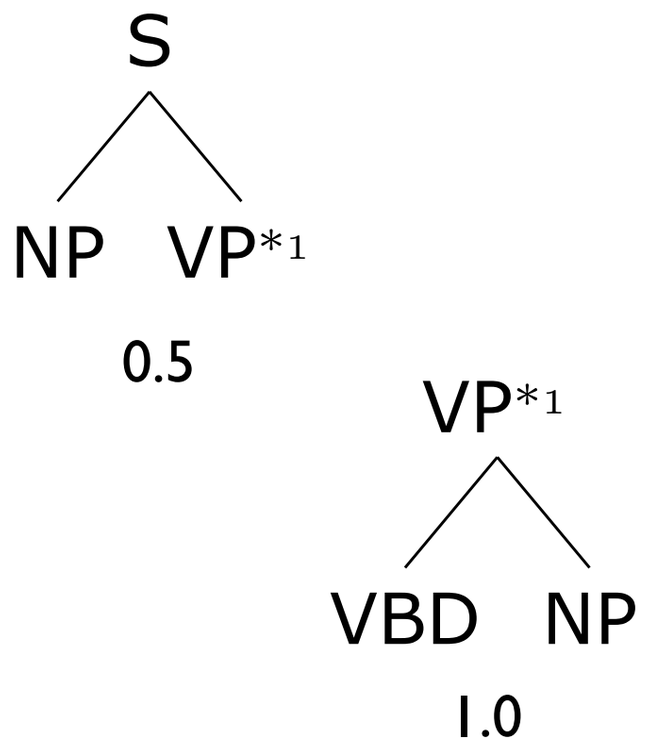
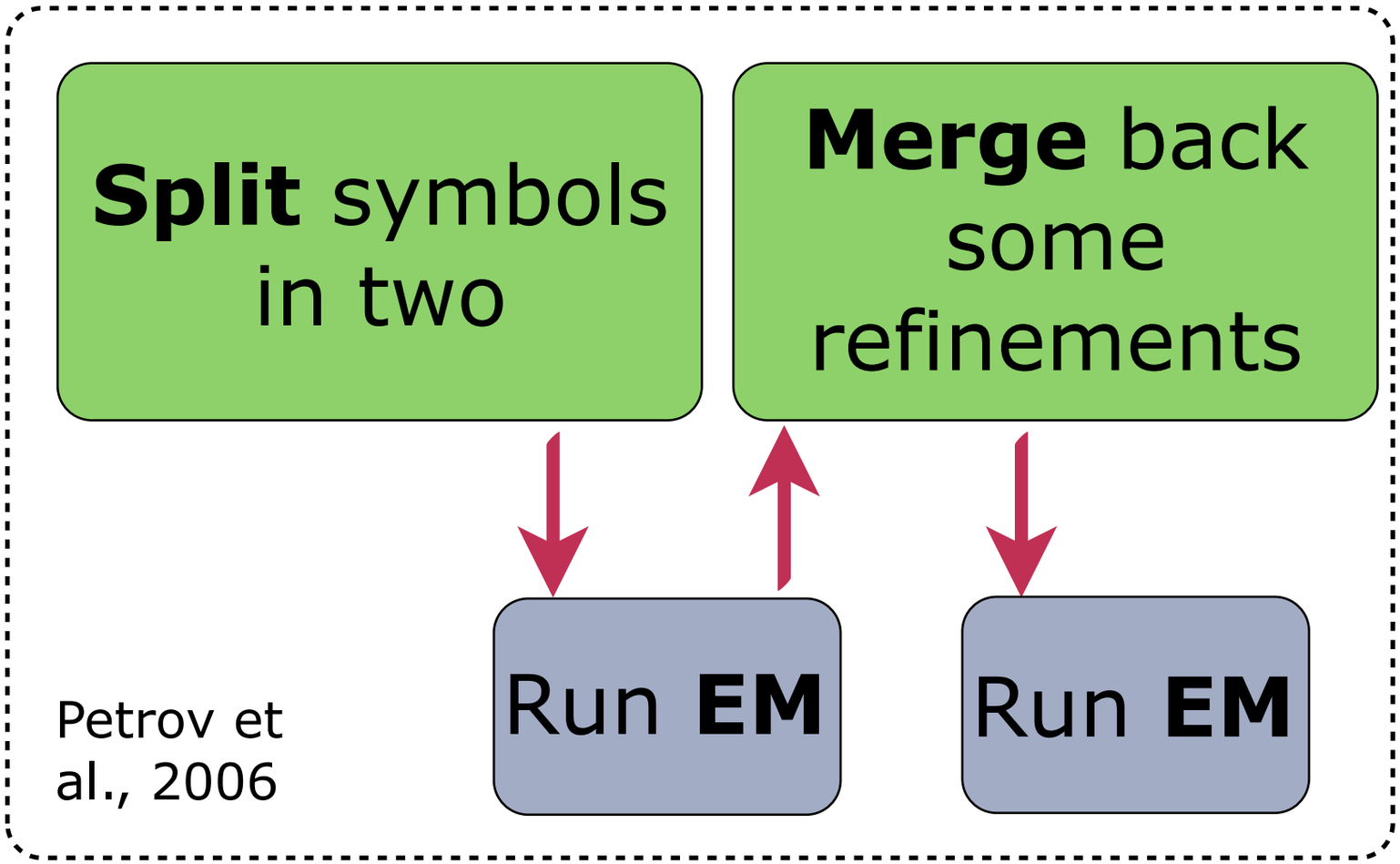




Algorithm Overview



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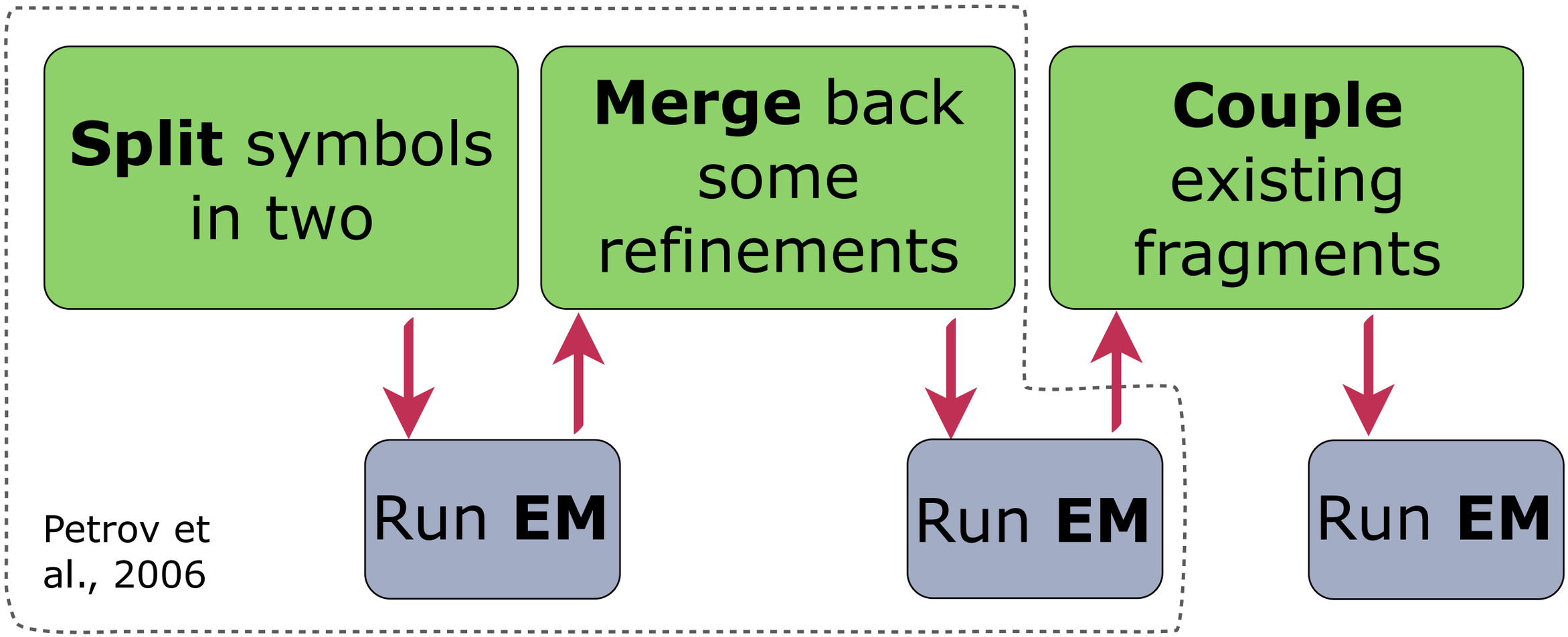

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- Use binary trees
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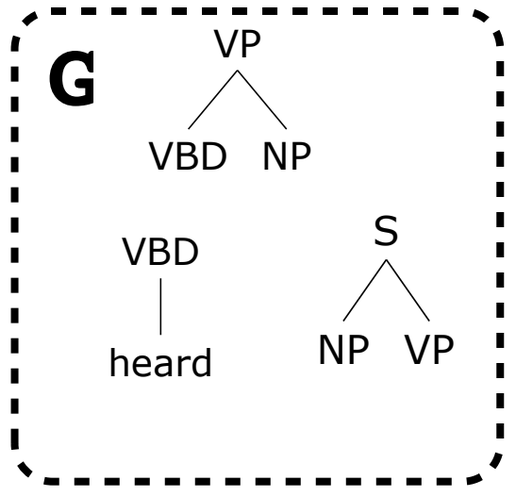

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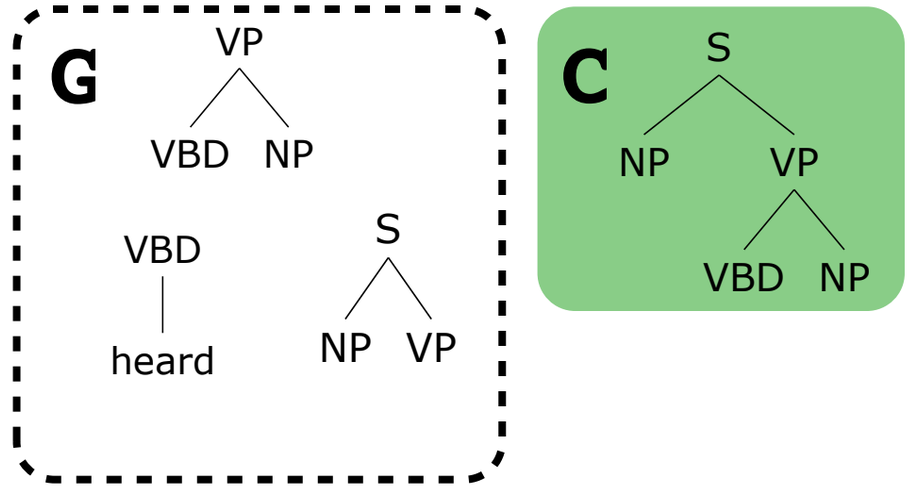

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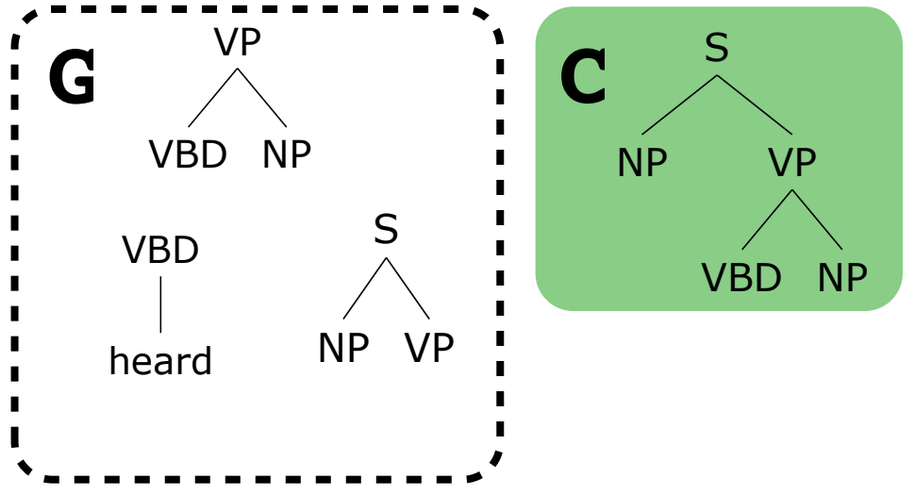

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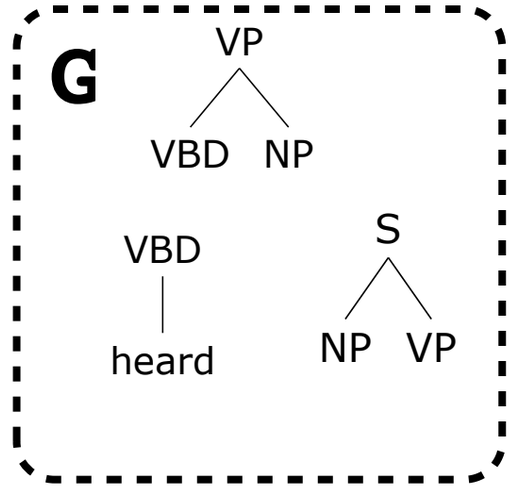

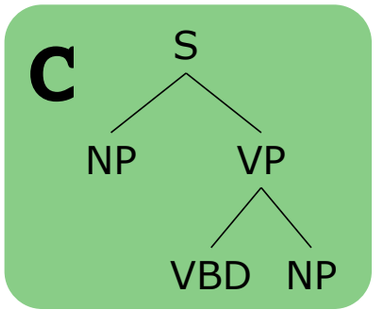

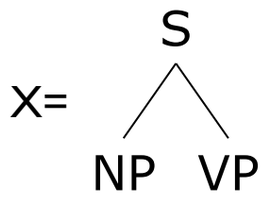

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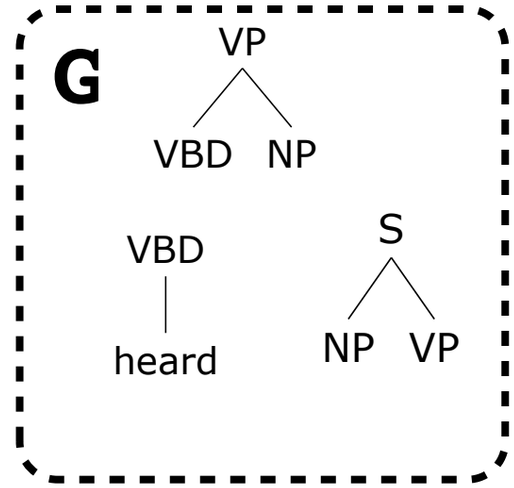

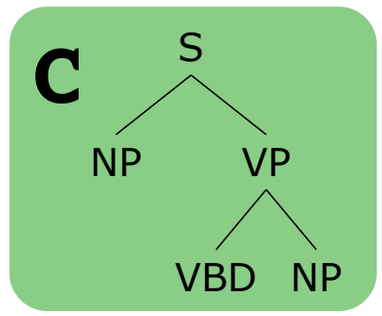

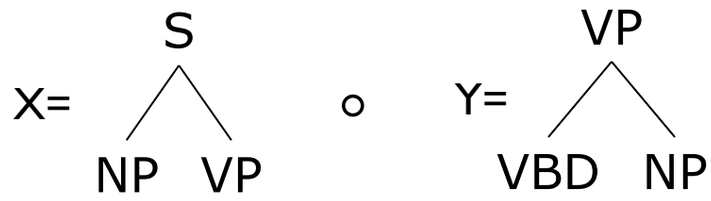

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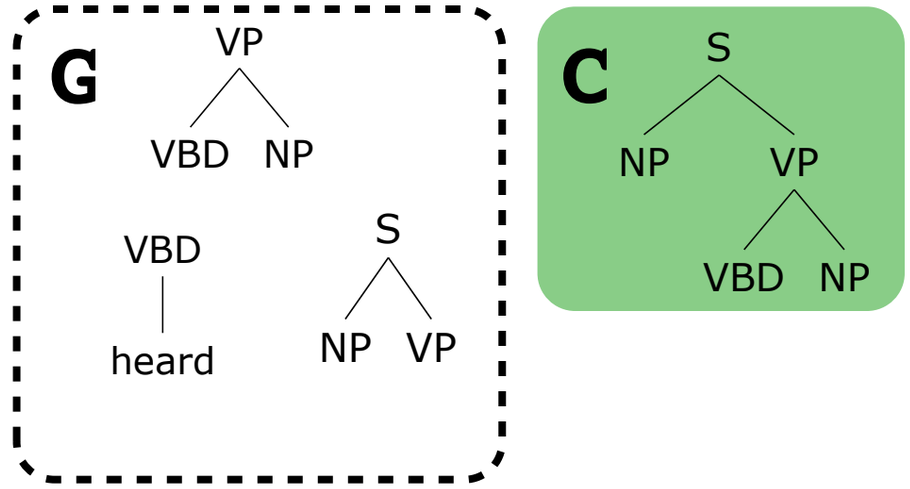

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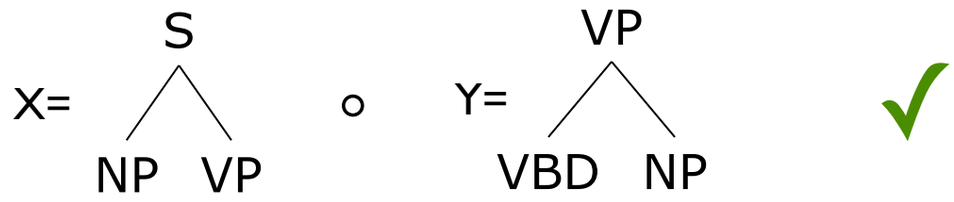

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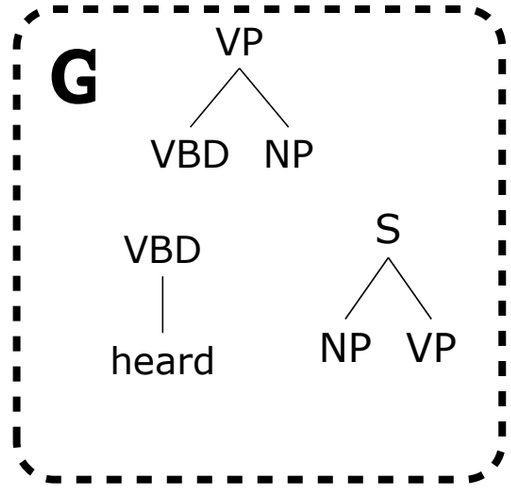

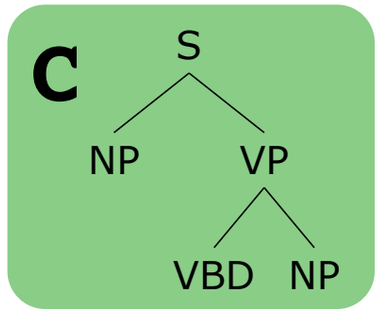

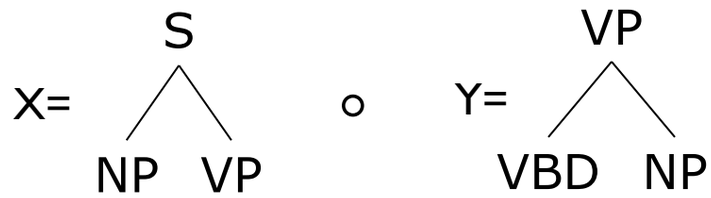

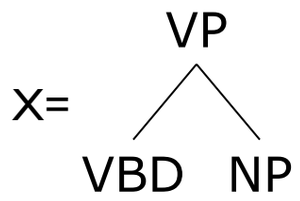

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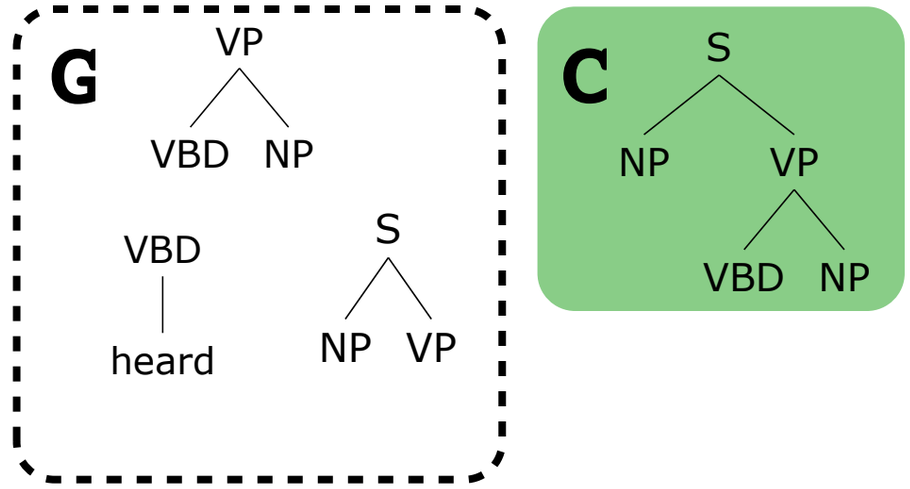

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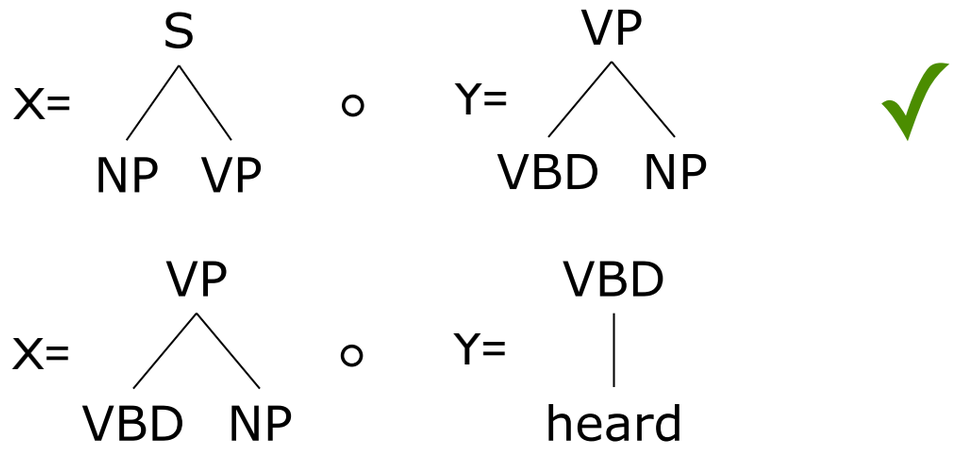

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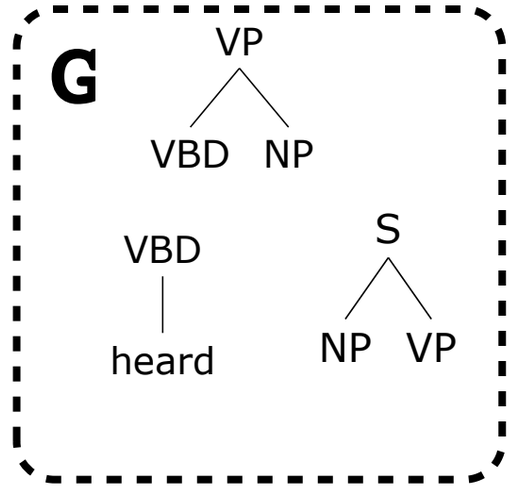

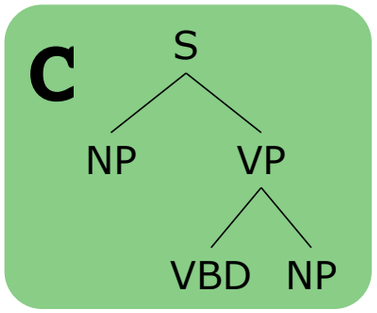

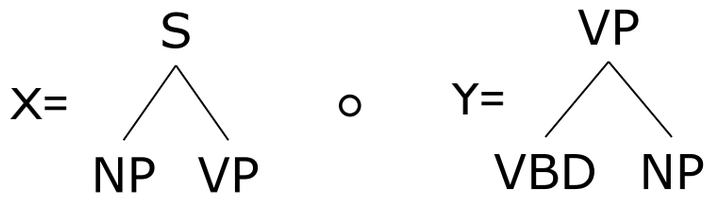

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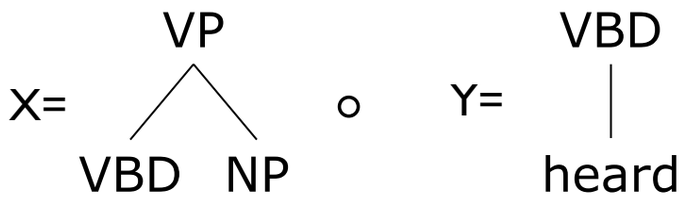

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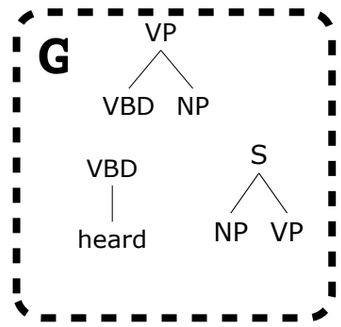

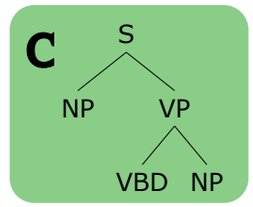

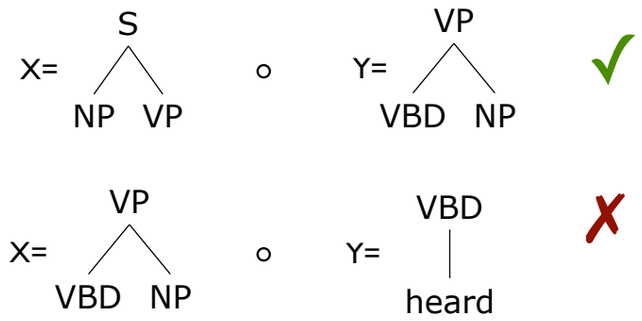

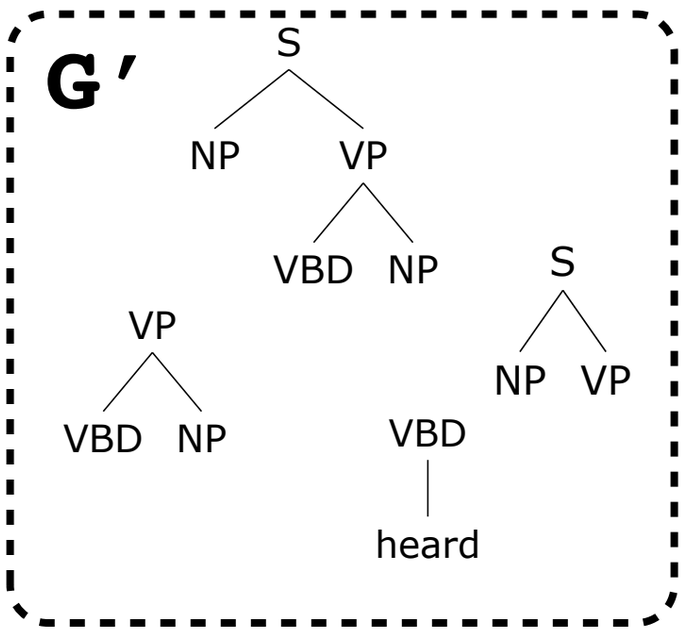

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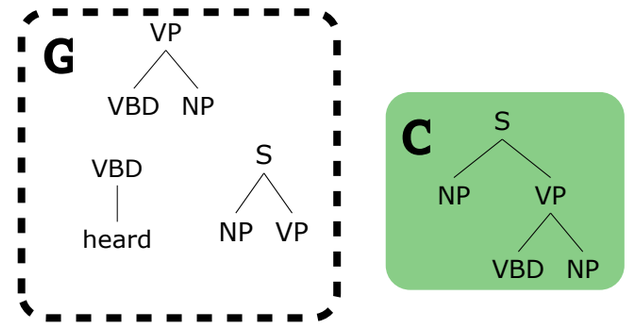
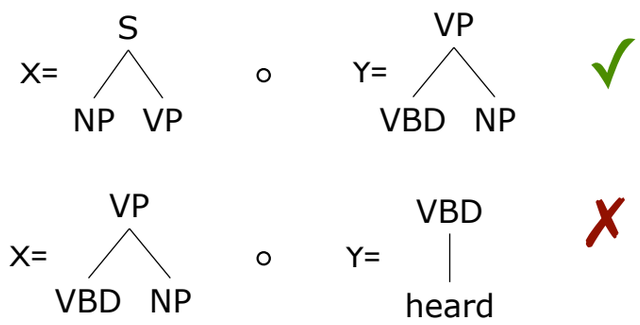
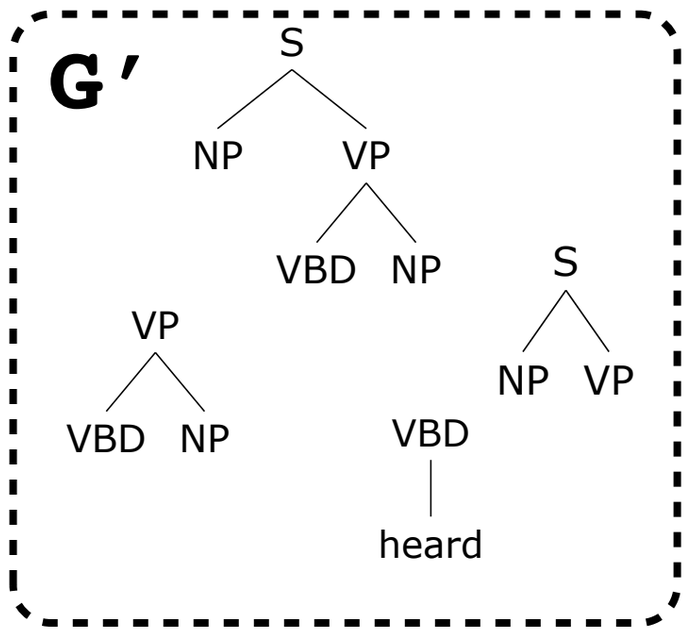
2. Estimate initial **G′** fragment weights







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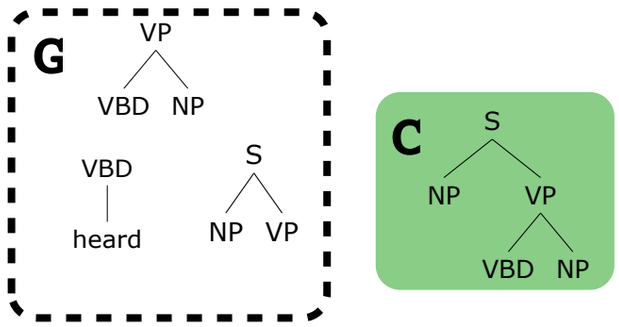

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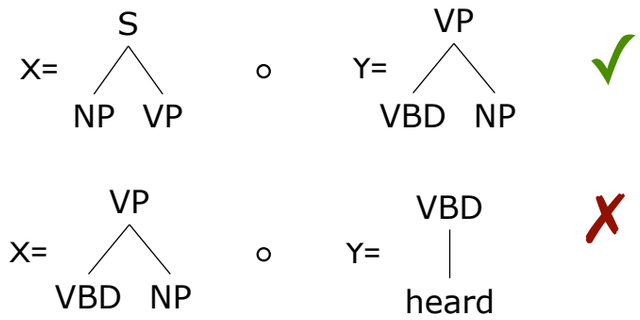
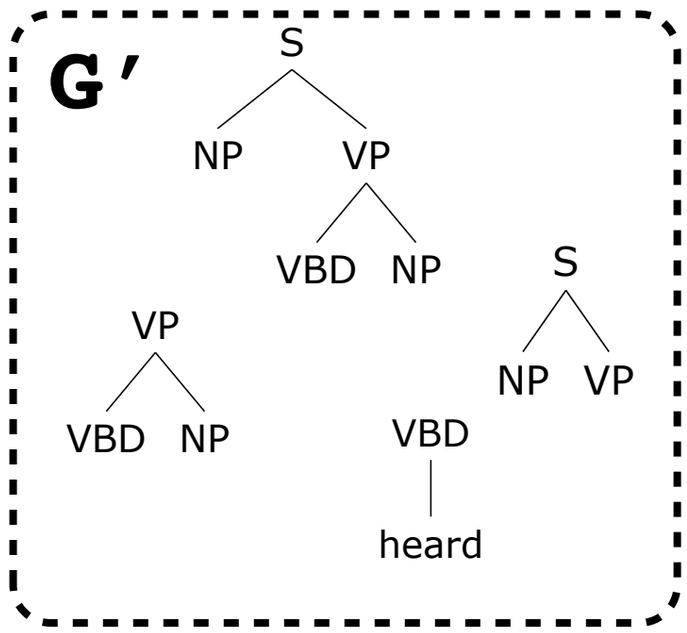


2. Estimate initial **G′** fragment weights
   - Uniform redistribution not appropriate



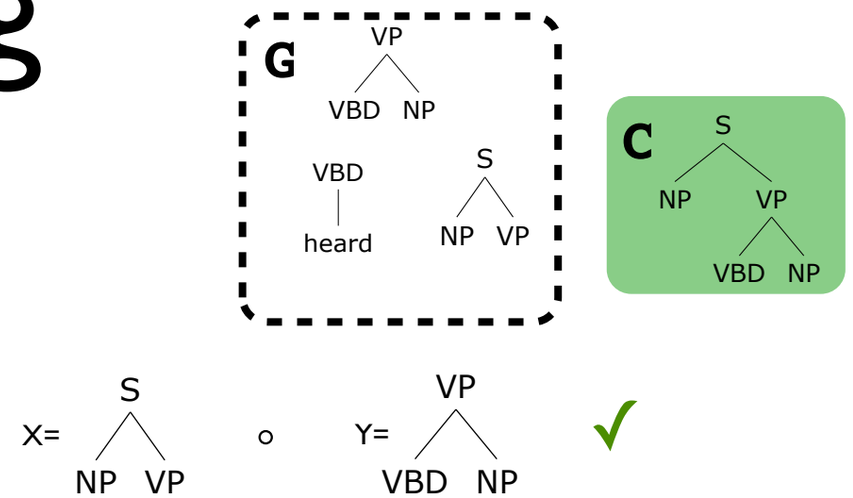
Coupling

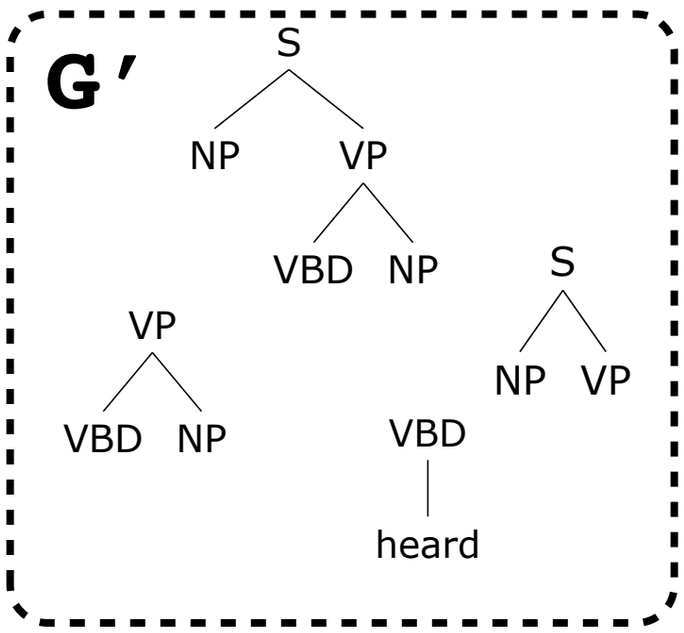
Given a grammar **G**, constraint set **C**:

1. Construct a grammar **G′** from **G** and allowed couplings from **C**

$$\mathbf{G'} = \mathbf{G} \cup \{X \circ Y \in \mathbf{C} \mid X \in \mathbf{G}\}$$

2. Estimate initial **G′** fragment weights
   - Uniform redistribution not appropriate
3. Fit weights of **G′** via inside/ outside





Deriving the Constraint Set

- Deterministically count compact TSG fragments
- Iteratively extract the *K* most frequent subtrees of size *R*
- *R*, *K* enforce sparsity and control what can and cannot couple

EXTRACTFRAGMENTS(R,K)

```
S ← ∅
F(1,K) ← top K CFG rules used
for r = 2 to R do
    S ← {F ∈ F(r-1, K), extended by 1 rule}
    F(r,K) ← top K elements of F(r-1, K) U S
end for
```

Qualitative Evaluation

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- Korean Treebank v2.0
- Sect. 2-3 of Penn Treebank (WSJ)

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WSJ, §2-3

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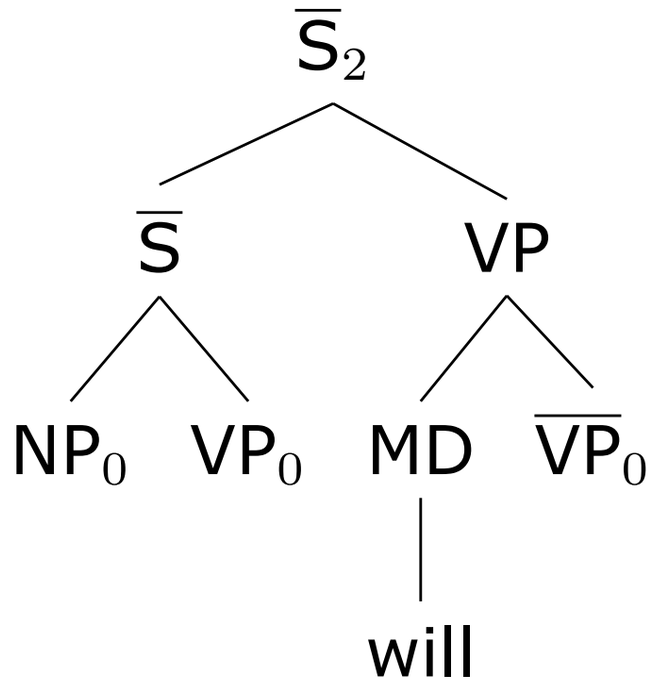
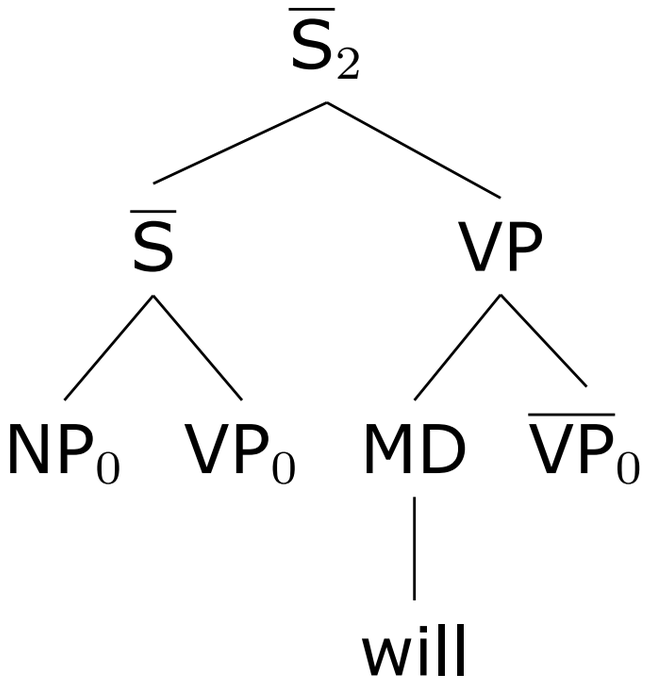
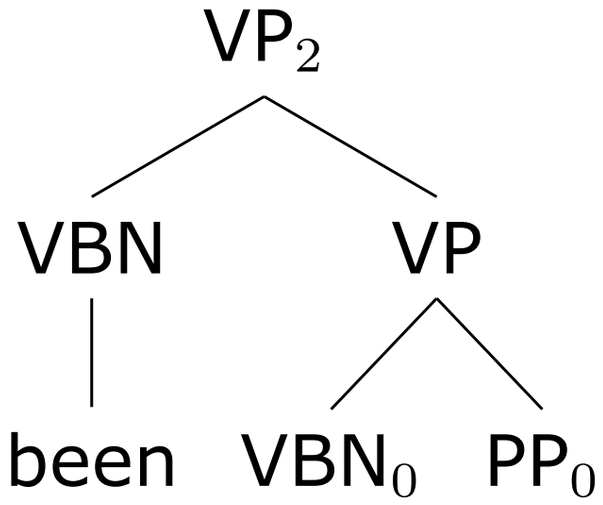


Modals

WSJ, §2-3

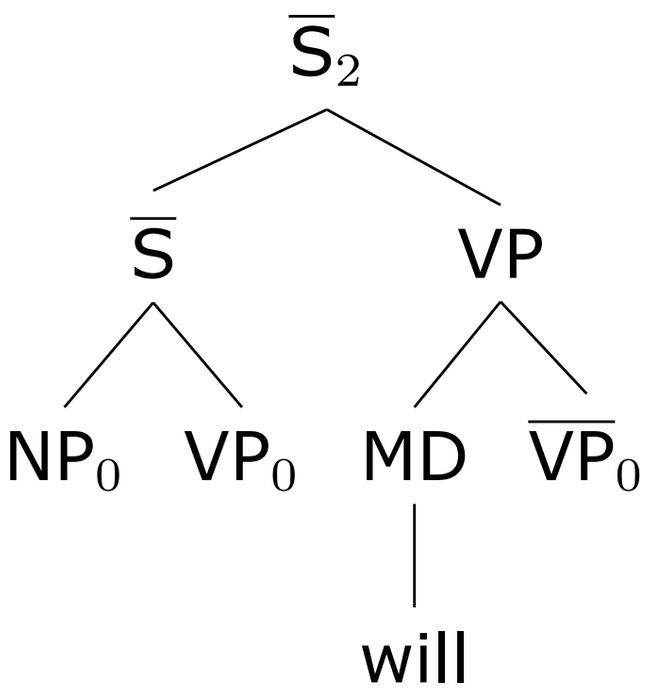


Modals

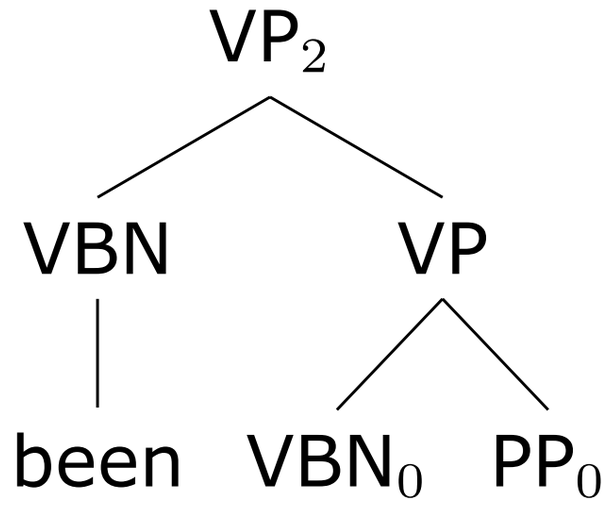


Perfectives

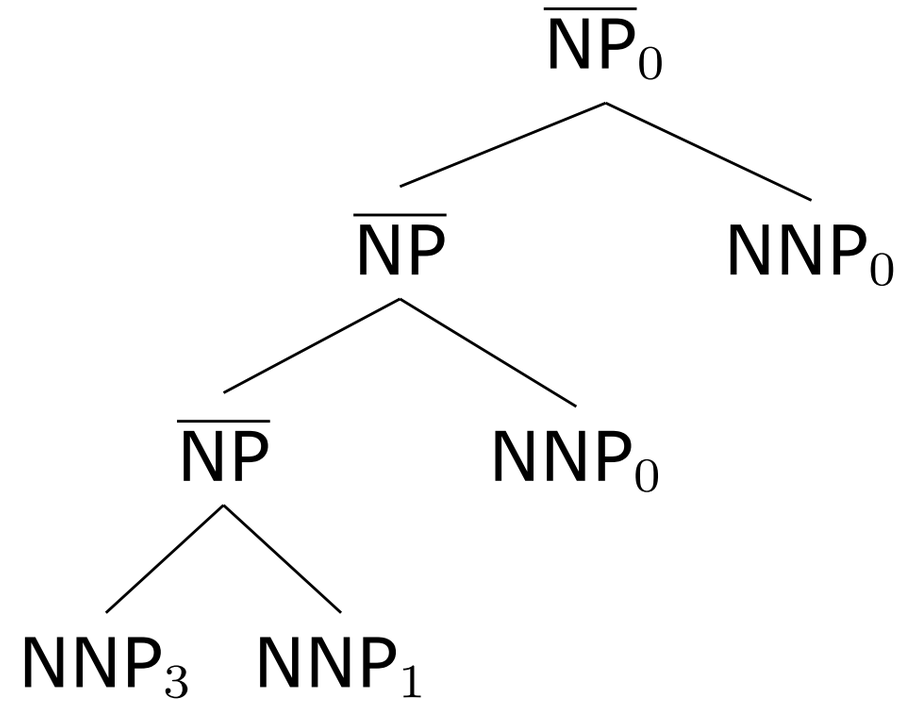
WSJ, §2-3



Modals



Perfectives



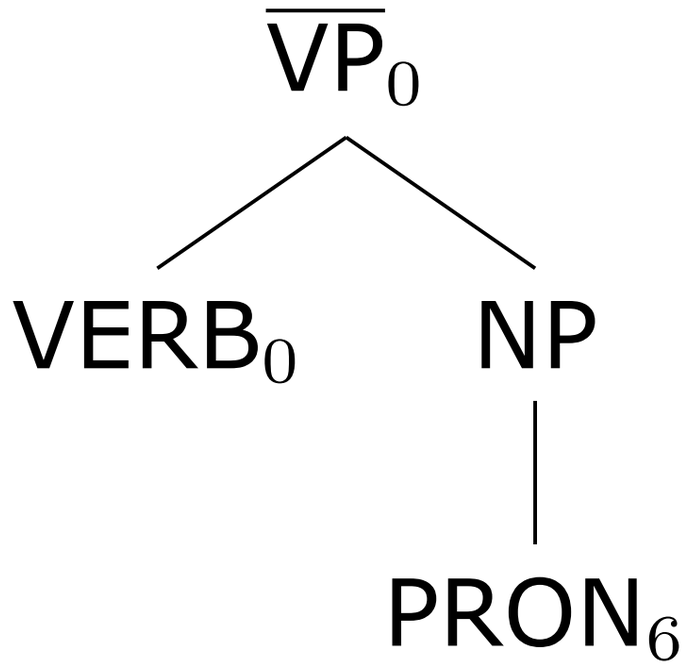
Nominals

Universal Tag Set, WSJ, §2-3

	PRON
1	its, his, your
5	it, he, they
6	it, them, him

Universal Tag Set, WSJ, §2-3

	PRON
1	its, his, your
5	it, he, they
6	it, them, him



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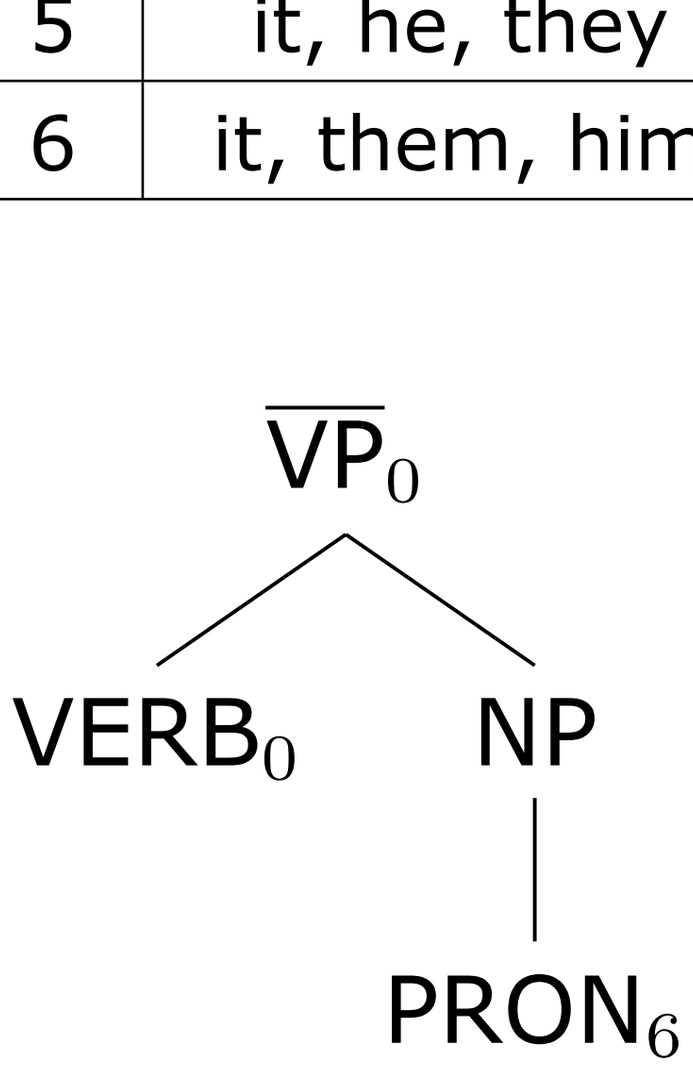

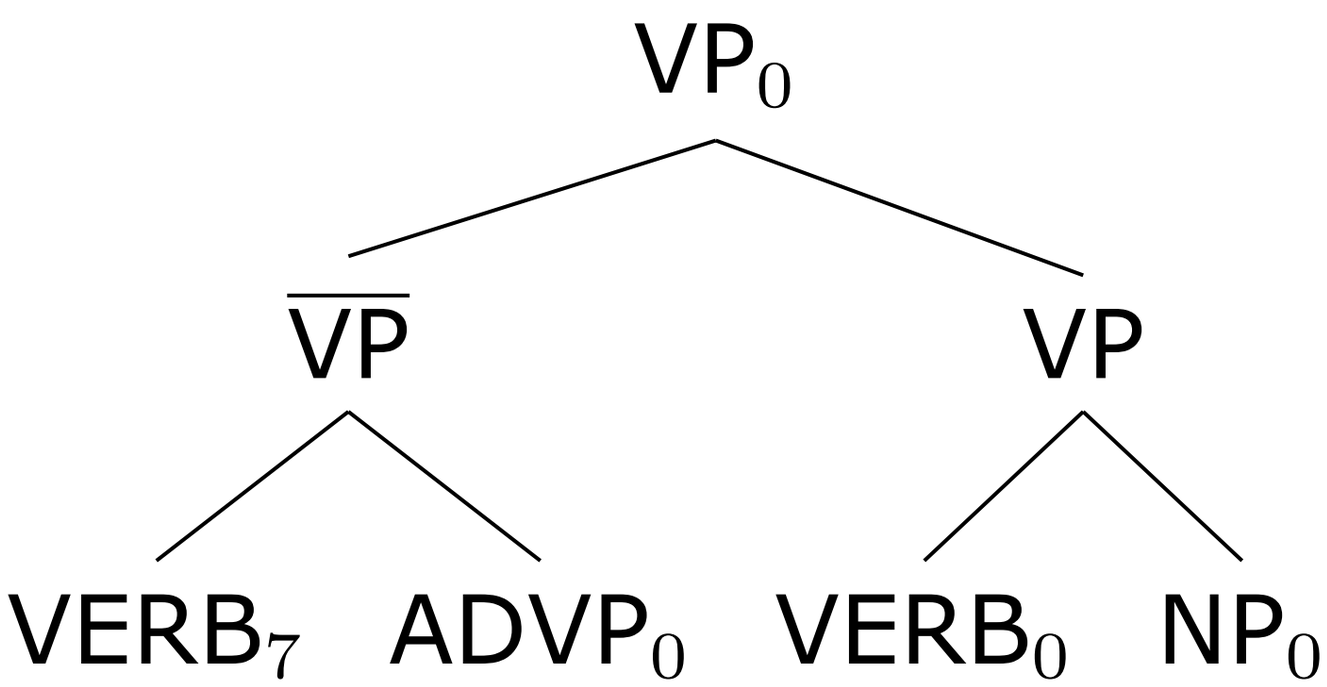

Thank you!