Expressive Power of Combinatory Categorial Grammars

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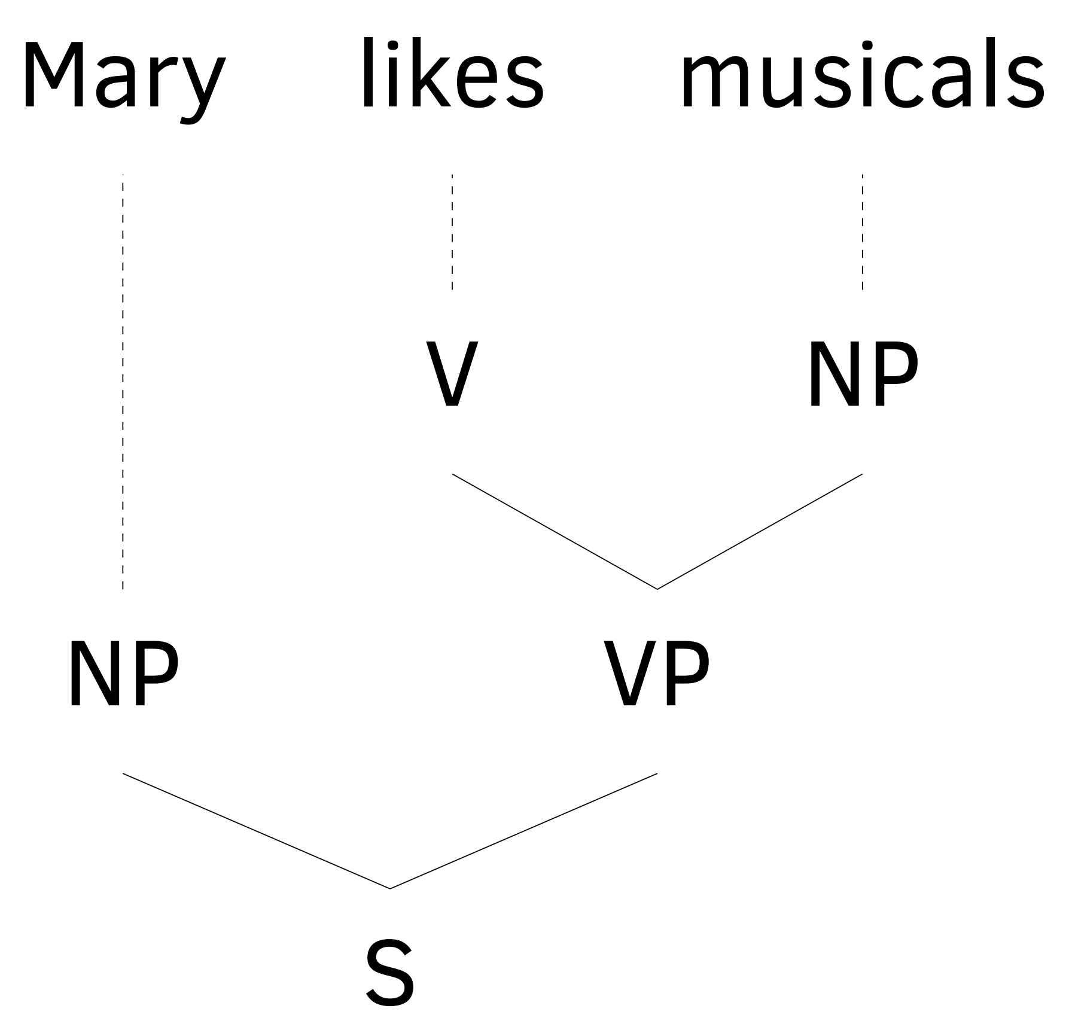
Combinatory Categorial Grammar

- widely used in **computational linguistics**
- **mildly context-sensitive** grammar formalism
- **efficiently parsable**
- **constituency-based** structures

Application Example



$$\dfrac{\overset{\text{Mary}}{NP} \quad \dfrac{\overset{\text{likes}}{S\backslash NP/NP} \quad \overset{\text{musicals}}{NP}}{S\backslash NP}}{S}$$

How does a CCG work?

- **lexicon** associates each input symbol with a set of **categories**
- **rule system** describes how adjoining categories can be combined
- derivation is sucessful if the derivation tree is rooted in an **initial category**

- **accepted tree languages** of a CCG are the relabeled sets of derivation trees
- derivation trees are always **binary trees**

Example for $a^n b^n$

- input alphabet $\Sigma = \{a, b\}$
- atomic categories $A = \{C, D\}$
- set of initial categories $I = \{C\}$

- lexicon L with
  $L(a) = \{C/D,\ C/D/C\}$
  $L(b) = \{D\}$

$$\dfrac{\dfrac{\overset{a}{C/D/C} \quad \dfrac{\overset{a}{C/D} \quad \overset{b}{D}}{C}}{C/D} \quad \overset{b}{D}}{C}$$

Rule System

Forward Rule

$$\dfrac{D/C/E/D \quad D/E\backslash C}{D/C/E/E\backslash C}$$

Backward Rule

$$\dfrac{C/D/E \quad D\backslash C/E\backslash C}{D\backslash C/E/D/E}$$

What classes of tree languages can CCG accept?

- **0-CCG** $\subsetneq$ **regular tree languages**
- **1-CCG** $=$ **regular tree languages**
- **k-CCG** $=$ **tree adjoining languages**

Why is this question important?

For parsing natural languages, you want as much power as necessary to model linguistic structures but not more to limit **parsing complexity**.

Future Work

tree language expressivity of

- CCG with **substitution rules**
- **weighted** CCG

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