

ACS Syntax and Semantics of Natural Language

Lecture 1: Introduction to Categorical Grammar



UNIVERSITY OF
CAMBRIDGE

Stephen Clark

Natural Language and Information Processing (NLIP) Group

`sc609@cam.ac.uk`

-
- Main responsibility for defining syntactic form is in the **lexicon**
 - Hence CG is a **lexicalized** theory of grammar
 - along with other theories of grammar such as HPSG, TAG, LFG, ...
 - Attractive linguistically because all language-dependent properties reside in the lexicon
 - small number of combination rules are language-invariant
 - Also attractive computationally; e.g. *supertagging* for Categorial Grammar leads to highly efficient parsing (Clark and Curran, 2007)

-
- Categorical Grammar has a strong commitment to Frege's **Principle of Compositionality** (along with Montague from the 70s):
 - *The meaning of a phrase is a function of the meanings of the parts of the phrase and how those parts are put together*
 - mathematically often described as a *homomorphism* (structure-preserving mapping) between syntactic and semantic representations (more on this later ...)

- Early Chomskian approach and much work in Generative Grammar uses rewrite rules or productions (as in a Context Free Grammar):

$$S \rightarrow NP VP$$
$$VP \rightarrow TV NP$$
$$TV \rightarrow \{likes, sees, \dots\}$$

- Categorical Grammar captures the same information by assigning a functional type, or *category*, to grammatical entities
- Has roots in early work by Polish mathematician Ajdukiewicz (1935) and even earlier in Russel's theory of types

-
- An elementary syntactic structure – a **lexical category** – is assigned to each word in a sentence, eg:

walked: $S \backslash NP$ ‘give me an NP to my left and I return a sentence’

- Think of the lexical category for a verb as a *function*: NP is the argument, S the result, and the slash indicates the direction of the argument

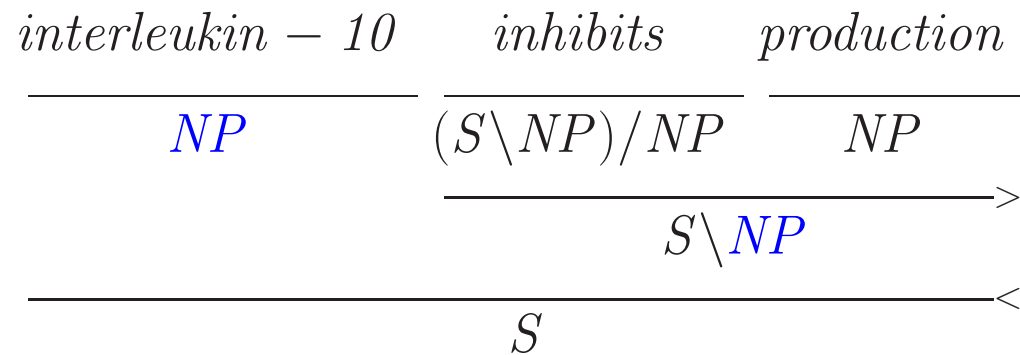
-
- Atomic categories: S , N , NP , PP , ... (not many more)
 - Complex categories are built recursively from atomic categories and slashes
 - Example complex categories for verbs:
 - intransitive verb: $S \backslash NP$ *walked*
 - transitive verb: $(S \backslash NP) / NP$ *respected*
 - ditransitive verb: $((S \backslash NP) / NP) / NP$ *gave*

$$\frac{\textit{interleukin} - 10}{NP} \quad \frac{\textit{inhibits}}{(S \setminus NP) / NP} \quad \frac{\textit{production}}{NP}$$

$$\frac{\textit{interleukin} - 10}{NP} \quad \frac{\textit{inhibits}}{(S \setminus NP) / NP} \quad \frac{\textit{production}}{NP}$$

$$S \setminus NP \rightarrow$$

> forward application



- > forward application
- < backward application

- Can think of the categories in blue as “cancelling”
 - early work in CG talks about “cancellation rules”
- Also looks a bit like multiplication and division
- But fundamentally the lexical category for the verb is a function which is applied to its argument

-
- ‘Classical’ Categorical Grammar only has application rules
 - Classical Categorical Grammar is context free
 - So what is different to CFG?
 - lexicalisation means that the information in CFG rewrite rules has been pushed down to the leaves of the derivation

[show graphic]

-
- Categorical Grammar, Mark Steedman, 1999. Short encyclopedia entry for MIT Encyclopedia of Cognitive Sciences, R. Wilson and F. Keil (eds.) available at: <http://homepages.inf.ed.ac.uk/steedman/papers.html>
 - Wide-Coverage Efficient Statistical Parsing with CCG and Log-Linear Models, Stephen Clark and James R. Curran, Computational Linguistics, 33(4), pp.493-552, 2007 (available online)
 - My video lecture on statistical parsing with CCG (pointer from my web page): http://videlectures.net/clspss09_clark_lspl/