ACS Syntax and Semantics of Natural Language

Lecture 1: Introduction to Categorial Grammar

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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)
• Categorial 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):

\[
S \rightarrow NP \ VP \\
VP \rightarrow TV \ NP \\
TV \rightarrow \{likes, sees, \ldots\}
\]

• Categorial 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 Russell’s theory of types
Lexical Categories

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

  \textit{walked}: S\backslash NP \quad \text{‘give me an NP to my left and I return a sentence’}

• Think of the lexical category for a verb as a \textit{function}: NP is the argument, S the result, and the slash indicates the direction of the argument
Lexical Categories

• 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
interleukin – 10 inhibits production NP
\( \frac{S\backslash NP}{NP} \) NP
### A Simple CG Derivation

<table>
<thead>
<tr>
<th>interleukin − 10</th>
<th>inhibits</th>
<th>production</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP</td>
<td>(S\NP)/NP</td>
<td>NP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S\NP</td>
</tr>
</tbody>
</table>

> forward application
A Simple CG Derivation

\[
\begin{align*}
\text{interleukin} - 10 & \quad \text{inhibits} \quad \text{production} \\
\text{NP} & \quad (S\backslash NP)/NP \quad \text{NP} \\
\quad & \quad S\backslash NP \\
\quad & \quad S
\end{align*}
\]

> forward application

< backward application
Combination Rules in CG

- 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’ Categorial Grammar only has application rules
• Classical Categorial 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
Readings


- My video lecture on statistical parsing with CCG (pointer from my web page): http://videolectures.net/clspss09_clark_lspl/