Syntactic Theory

Lecture 1 (28.10.2010)

PD Dr.Valia Kordoni

Email: kordoni@coli.uni-sb.de

http://www.coli.uni-saarland.de/~kordoni/

Syntax: What does it mean?

We can view syntax/syntactic theories in a number of ways, two of which are the following:

- Psychological way/model: syntactic structures correspond to what is in heads of speakers and hearers
- Computational way/model: syntactic structures are formal objects which can be mathematically treated/manipulated

Syntactic Analysis

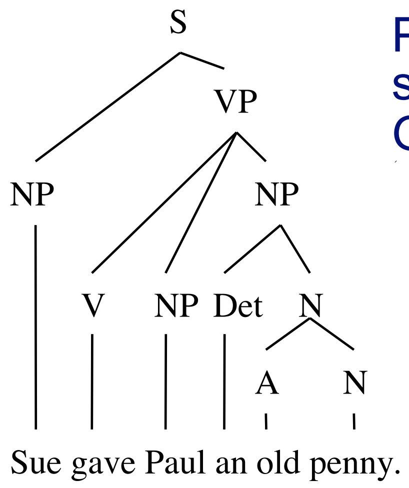
- Focus on collection of words and rules with which we generate strings of those words, i.e., sentences (generative grammar)
- Syntax attempts to capture the nature of those rules
  1. Colourless green ideas sleep furiously.
  2. *Furiously sleep ideas green colourless.
- What generalisations are needed to capture the difference between grammatical and ungrammatical sentences?

Phrase Structure Grammars (PSGs)

- Grouping, or constituency, is used

(1) Sue gave Paul an old penny.

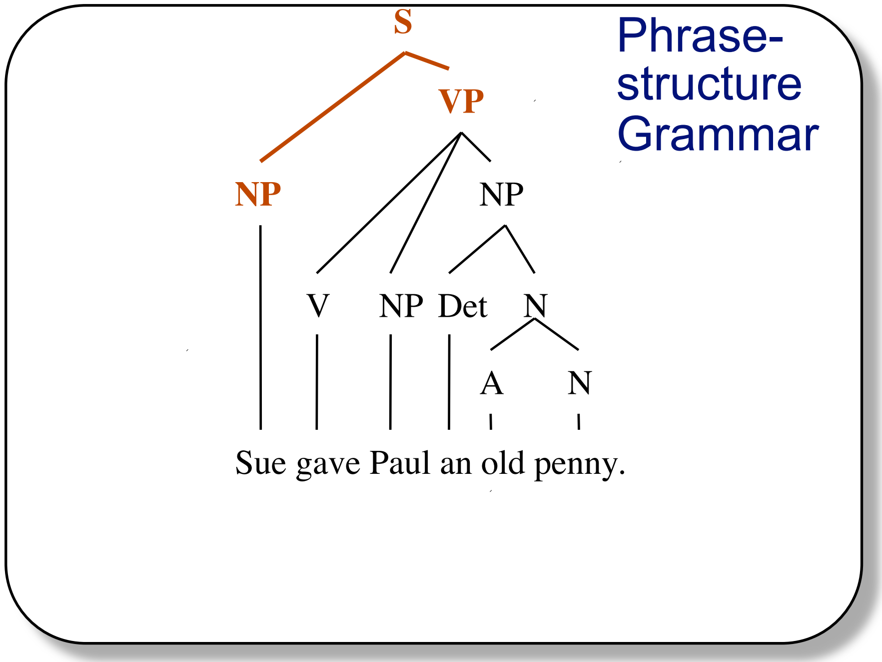
Phrase Structure Grammars (PSGs)



Phrase-structure Grammar

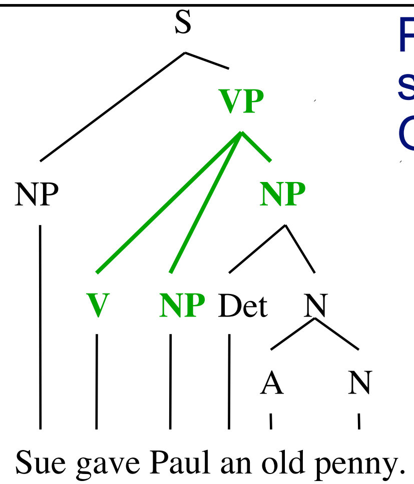
S → NP VP

Phrase Structure Grammars (PSGs)



S → NP VP

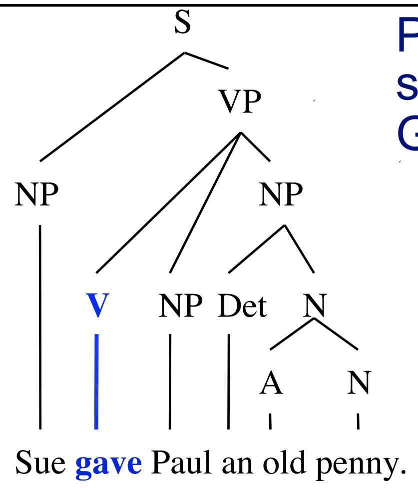
Phrase Structure Grammars (PSGs)



Phrase-structure Grammar

S → NP VP
VP → V NP NP

Phrase Structure Grammars (PSGs)



Phrase-structure Grammar

S → NP VP
VP → V NP NP

V → gave

UNIVERSITÄT DES SAARLANDES

The Transformational Tradition

Roughly speaking, **transformational syntax** (GB = Government and Binding, P&P = Principles and Parameters,...) has focused on the following:

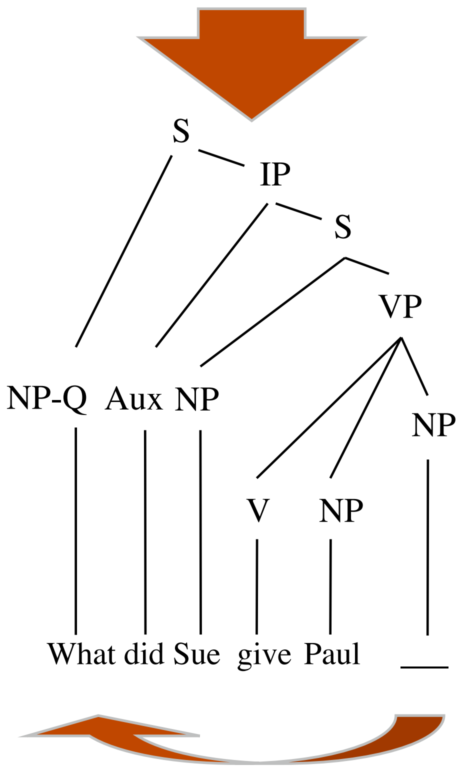
- Explanatory adequacy: the data must fit with a deeper model, that of universal grammar
- Psychological: does the grammar make sense in light of what we know of how the mind works?
- Theory-driven: data should ideally fit with a theory already in place (often based on English)

The Transformational Tradition (cont.)

- Universality: generalisations must be applicable to all languages
- Transformations: (surface) sentences are derived from underlying other sentences, e.g., passives are derived from active sentences

The Transformational Tradition (cont.)

Sue gave Paul an old penny



The Transformational Tradition (cont.)

But this kind of theory does not lend itself well to computational applications

Making it computational

How is a syntactic theory useful for computational linguistics?

- Parsing: take an input sentence and return the syntactic analysis and/or state whether it is a valid sentence
- Generation: take a meaning representation and generate a valid sentence

=> Both tasks are often subparts of practical applications, such as Machine Translation (MT) and Dialogue systems, for instance

Computational Needs

To use a grammar for parsing or generation, we need to have a grammar that meets several criteria:

- Accurate: gives a correct analysis
- Precise: tells a computer exactly what it is that one wants it to do
- Efficient: able to parse a sentence and return one or only a small number of parses
- Useful: is relatively easy to map a syntactic structure to its meaning

=> These needs are not necessarily why the computational formalisms were developed, but they are some of the reasons why people use them.

Computational Grammar Formalisms

Computational Grammar formalisms share several properties:

- Descriptive adequacy
- Precise encodings (implementable)
- Constrained mathematical formalism
- Monostratalism
- (Usually) high lexicalism

Descriptive Adequacy

Some researchers try to explain the underlying mechanisms, but we are most concerned with being able to *describe* linguistic phenomena

- Provide a structural description for every well-formed sentence
- Gives us an accurate encoding of a language
- Gives us broad-coverage, i.e., can (try to) describe all of a language

  → No notion of core and periphery phenomena

Precise Encodings

Mathematical Formalism: formal way to generate sets of strings

Precisely define:

- elementary structures
- ways of combining those structures

=> Such an emphasis on mathematical precision makes these grammar formalisms more easily implementable

Constrained Mathematical Formalism

A formalism must be **constrained**, i.e., it cannot be allowed to specify all strings

- Linguistic motivation: limits the scope of the theory of grammar
- Computational motivation: allows us to define efficient processing models

Monostratal Frameworks

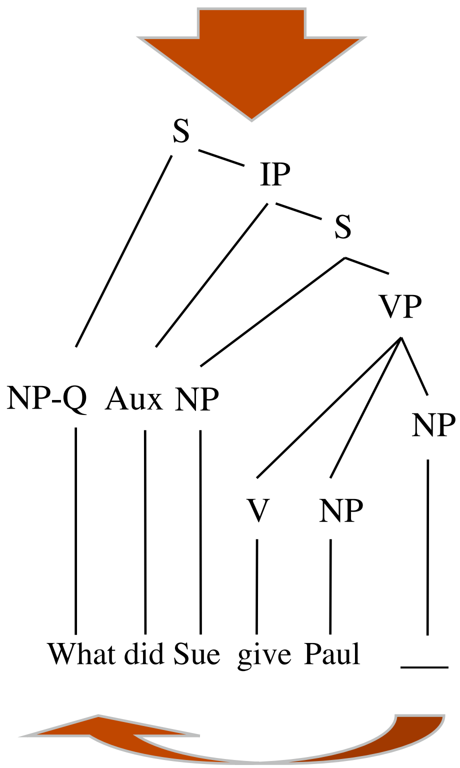
Only have one (surface) syntactic level

- Make no recourse to movement
- Augment your basic (phrase structure) tree with information that can describe „movement" phenomena

=> Without having to refer to movement, easier to process sentences on a computer

This should be avoided!

Sue gave Paul an old penny



Lexical

In the past, rules applied to broad classes and only some information was put in the lexicon, e.g., subcategorisation information

- Linguistic motivation: lexicon is the best way to specify some generalisations: *He told/*divulged me the truth*
- Computational motivation: can derive lexical information from corpora (large computer-readable texts)

=> Shift more of the information to the lexicon; each lexical item may be a complex object

Context-Free Grammars (CFGs)

Context-Free Grammars (CFGs) are one kind of constrained mathematical formalism, a precise way of encoding syntactic rules:

- elementary structures: rules composed of non-terminal and terminal elements
- combine rules by rewriting them

Context-Free Rules

Example of a set of rules:

- S → NP VP
- NP → Det N
- VP → V NP
- ...

But these rules are rather impoverished.

Are CFGs good enough?

- Data from various languages show that CFGs are not powerful enough to handle all natural language constructions
- CFGs are not easily lexicalised
- CFGs become complicated once we start taking into account agreement features, verb subcategorisations, unbounded dependency constructions, raising constructions, etc.

We need more refined formalisms...

Beyond CFGs

Move beyond CFGs, but stay „mathematical“:

- Extend the basic model of CFGs with, for instance, complex categories, functional structure, feature structures, ...
- Eliminate CFG model (or derive it some other way)

Computational Grammar Frameworks

- Dependency Grammar (DG)
- Tree-Adjoining Grammar (TAG)
- Combinatory Categorial Grammar (CCG)
- Lexical Functional Grammar (LFG)
- Head-Driven Phrase Structure Grammar (HPSG)

Dependency Grammar (DG)

- The way to analyse a sentence is by looking at the relations between words
- A verb and its valents/arguments drive an analysis, which is closely related to the semantics of a sentence
- No grouping, or constituency, is used

Tree-Adjoining Grammar (TAG)

- Elementary structures are trees of arbitrary height
- Trees are rooted in lexical items, i.e., lexicalised
- Put trees together by substituting and adjoining them, resulting in a final tree which looks like a CFG-derived tree

Combinatory Categorial Grammar (CCG)

- Categorial Grammar derives sentences in a proof-solving manner, maintaining a close link with a semantic representation
- Lexical categories specify how to combine words into sentences
- CCG has sophisticated mechanisms that deal nicely with coordination, extraction, and other constructions

Lexical Functional Grammar (LFG)

- Functional structure (subject, object, etc.) divided from constituent structure (tree structure)
  - kind of like combining dependency structure with phrase structure
- Can express some generalisations in f-structure; some in c-structure; i.e., not restricted to saying everything in terms of trees

Head-driven Phrase Structure Grammar (HPSG)

- Sentences, phrases, and words all uniformly treated as linguistic signs, i.e., complex objects of features
- Similar to LFG in its use of feature architecture
- Uses an inheritance hierarchy to relate different – types of objects (e.g., nouns and determiners are both types of nominal)