Final Word on Syntax?, Semantics and Pragmatics

CFG Notes; Typical phrase structure rules in English - (S) – (NP) – (AP) – (PP) – (VP); NL Phenomena; Heads, dependencies, arguments, adjuncts; Semantic analysis

Final Thoughts on Syntax (for now)

- – Syntax = sentence structure; i.e., study of the phrase structure
- – s´yntaxis (Greek) — "setting out together, arrangement"
- – words are not randomly ordered— word order is important and non-trivial
- – There are "free-order" languages (e.g., Latin, Russian), but they are not completely order free.
- – a hierarchical view of sentence structure:
- – words form phrases
- – phrases form clauses
- – clauses form sentences

Some Notions about CFGs

- CFG, also known as Phrase-Structure Grammar (PSG)
  - equivalent to BNF (Backus-Naur form)
  - idea from Wundt (1900), formally defined by Chomsky (1956) and Backus (1959)
  - typical notation (V, T, P, S)
  - direct derivation
  - language generated by CFG
  - left-most and right-most derivation
  - parse tree, parsing
  - ambiguous sentences, grammars

Bracket Representation of a Parse Tree

```
(S  (NP  (DT That)
         (NN man))
    (VP  (VBD caught)
         (NP  (DT the)
              (NN butterfly))
         (PP  (IN with)
              (NP  (DT a)
                   (NN net)
) ) ) ) )
```

Typical Phrase Structure Rules in English

S → NP VP	Declarative sentences, e.g.: I want a flight from Halifax to Chicago.
S → VP	Imperative sentences, e.g.: Show the lowest fare.
S → Aux NP VP	Yes-no questions, e.g.: Do any of these flights have stops? Can you give me some information for United?
S → Wh-NP VP	Wh-subject questions, e.g.: What airlines fly from Halifax?
S → Wh-NP Aux NP VP	Wh-non-subject questions, e.g.: What flights do you have on Tuesday?

About Typical Rules

- only some typical rules are presented
- for example: We see the cat, and you see a dog.
- the sentence could be described with: S → S CC S
- relative clauses are labeled in Penn treebank using SBAR nonterminal; e.g.:

```
(S (NP (NP Lorillard Inc.)
       ,
       (NP (NP the unit)
           (PP of (NP (ADJP New York-based)
                      Loews Corp.)))
       (SBAR that
             (S (NP *gap*)
                (VP makes (NP Kent cigarettes))))
       ,)
   (VP stopped (VP using (NP crocidolite))))
```

Noun Phrase (NP)

- typically: pronouns, proper nouns, or determiner-nominal construction
- some typical rules

  NP → PRP e.g.: you

  NP → NNP | NNPS e.g.: Halifax

  NP → PDT? DT JJ* NN PP*
- in the last rule, we use regular expression notation to describe a set of different rules
- example: all the various flights from Halifax to Toronto
- determiners and nominals
- modifiers before head noun and after head noun
- postmodifier phrases

NP → DT JJ* NN RelC

Relative Clauses

- RelC — relative clause
- clause (sentence-like phrase) following a noun phrase
- example: gerundive relative clause:
  flights arriving after 5pm
- example: infinitive relative clause:
  flights to arrive tomorrow
- example: restrictive relative clause:
  flight that was canceled yesterday

Verb Phrase (VP)

- organizes arguments around the verb
- typical rules

  VP → Verb intransitive verbs;
  e.g.: disappear
  VP → Verb NP transitive verbs:
  e.g.: prefer a morning flight
  VP → Verb NP NP ditransitive verbs:
  e.g.: send me an email
  VP → Verb PP* sentential complements
  VP → Verb NP PP*
  VP → Verb NP NP PP*
- sentential complements, e.g.:

  You said these were two flights that were the cheapest.

Prepositional Phrase (PP)

Typical:

PP → IN NP

- examples: from Halifax, before tomorrow, in the city
- PP-attachment ambiguity

Adjective Phrase (ADJP)

- less common
- examples:
  - She is very sure of herself.
  - … the least expensive fare …

Adverbial Phrase (ADVP)

- Example:

```
(S   (NP    preliminary findings)
     (VP    were reported
            (ADVP (NP a year) ago)))
```

- more examples: years ago, easily rejected

Natural Language Phenomena

Three well-known phenomena: Agreement, Movement, Subcategorization

- Agreement
- Movement
- Subcategorization

Agreement

- subject-verb agreement
  For example, “I work.” and “He works.” vs. *“I works.” and *“He work.”
- specifier-head agreement
  For example, “This book.” and “These books.” vs. *“This books.” and “These book.”

Agreement can be a non-local dependency, e.g:
The women who found the wallet were given a reward

Movement

e.g, wh-movement

Which book should Peter buy ?

filler *gap*

another example:

```
(S   (NP (NP Air Canada) ,
(NP (NP-*filler* one of many airline
companies)
        (SBAR that (S (NP-*gap*)
                      (VP flies from Halifax
                                  to Toronto))
        )) ,
(VP cancelled the flights yesterday) ) . )
```

Subcategorization

Example:

The problem disappeared. and
The defendant denied the accusation.

are two valid sentences, however, the following two are grammatically incorrect:

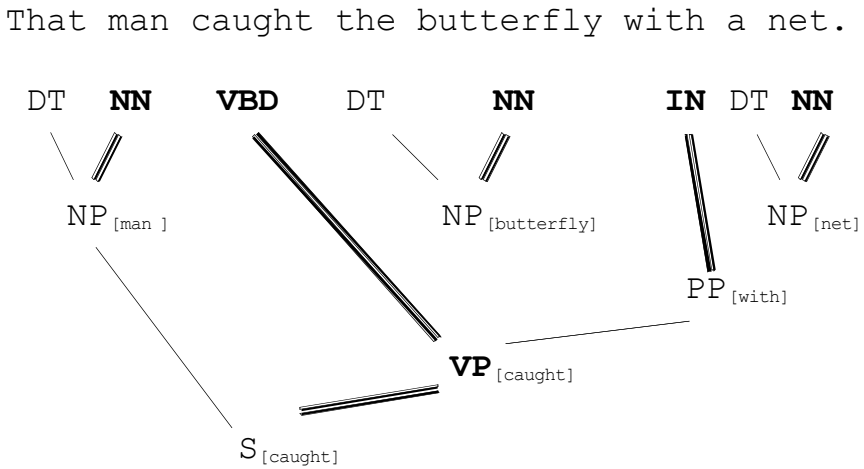
*The problem disappeared the accusation. and
*The defendant denied.

Explanation:

- "disappear" does not take an object (verb valence)
- "deny" requires an object

Heads and Dependency

- the parse tree of "That man caught the butterfly with a net."
- annotate dependencies, head words



- There is usually some way of annotating the head child among the left-hand-side symbols; e.g.,

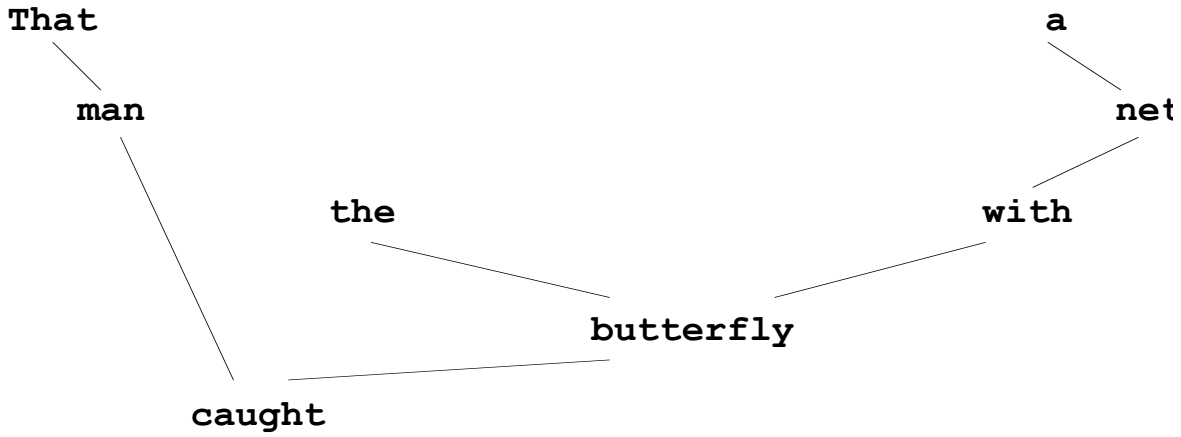
$$NP \rightarrow DT\ N_{NH} \quad \text{or} \quad [NP] \rightarrow [DT]\ H[NN]$$

Head-feature Principle

The features of a phrase are normally transferred from the features of the head word.

Dependency Tree

- dependency grammar
- example with “That man caught the butterfly with a net.”



Arguments and Adjuncts

- There are two kinds of dependents:
  1. arguments, which are required dependents, e.g.,

     We deprived him of food.
  2. adjuncts, which are not required;

     – they have a "less tight" link to the head, and

     – can be moved around more easily

     Example:

     We deprived him of food yesterday in the restaurant.

Semantic Analysis

- meaning representation, e.g., as language or data structure
- typically syntax-driven
- principle of semantic compositionality, exceptions
- computational requirements
  - verifiability
  - unambiguous representation
  - canonical form
  - inference
  - expressiveness
- example of a semantic representation language:

  First-Order Logic (FOL), and other logics

Lexical Semantics

- word meaning— basic elements for compositional semantics
- What is a word?
  - wordform— a word as it appears in text or speech;
    i.e., its orthographic or phonological representation
  - lexeme— a pair (wordform, meaning), with optionally more information
  - lexicon— a set of lexemes (or database)
  - lemma or citation form— as it appears in a dictionary
  - lemmatization— mapping of wordforms to lemmas

Semantic Compositionality

How meanings of the pieces combine into a meaning of the whole?

Levels of compositionality:

1. compositional semantics

   e.g., white paper = white + paper

2. collocations

   e.g., white wine white + wine

3. idioms, examples:

   kick the bucket ≠ kick + the bucket

   coupons are just the tip of the iceberg

Semantic Roles

Syntax is closely related to semantics.

For example, subcategorization frames can be used to assign semantic roles of the verb arguments. E.g., verb send, semantic frame: NP[subject], NP[indirect object] NP[direct object] can be used to assign semantic roles of: SENDER, RECIPIENT, and OBJECT, resulting in the frame:

```
Send
SENDER:        I
RECIPIENT:     you
OBJECT:        an e-mail
```

Semantic preference can be used to properly disambiguate the sentences:

- He ate the cake with a frosting. and
- He ate the cake with a spoon.

Other Concluding Remarks

MAKING AN EFFORT
Our so-called limitations, I believe,
apply to faculties we don't apply.
We don't discover what we can't achieve
until we make an effort not to try.