

Computational Linguistics

Lecture 7

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PARSING WITH CONTEXT-FREE GRAMMARS

Parsing with Context-Free Grammars

- The parser can be viewed as searching through the space of all possible parse trees to find the correct parse tree for the sentence.

$S \rightarrow NP VP$

$S \rightarrow Aux NP VP$

$S \rightarrow VP$

$NP \rightarrow Det Nominal$

$Nominal \rightarrow Noun$

$Nominal \rightarrow Noun Nominal$

$NP \rightarrow Proper-Noun$

$VP \rightarrow Verb$

$VP \rightarrow Verb NP$

$Det \rightarrow that \mid this \mid a$

$Noun \rightarrow book \mid flight \mid meal \mid money$

$Verb \rightarrow book \mid include \mid prefer$

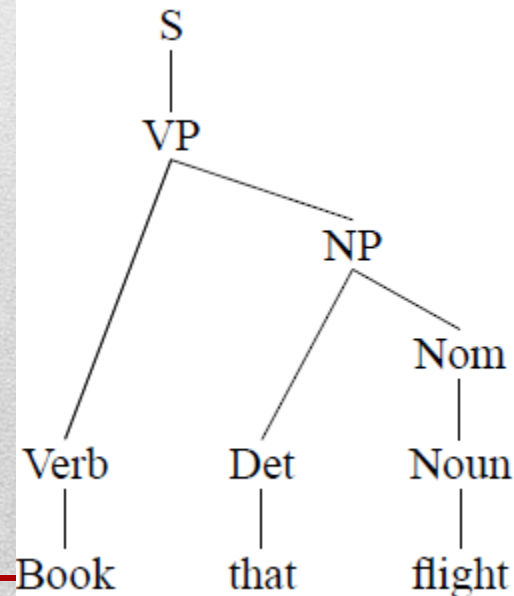
$Aux \rightarrow does$

$Prep \rightarrow from \mid to \mid on$

$Proper-Noun \rightarrow Houston \mid TWA$

$Nominal \rightarrow Nominal PP$

➤ Book that flight



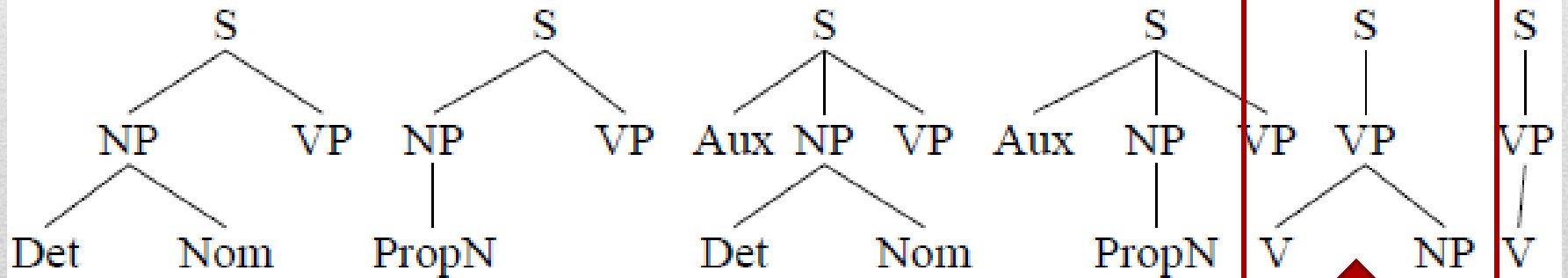
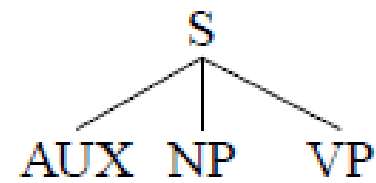
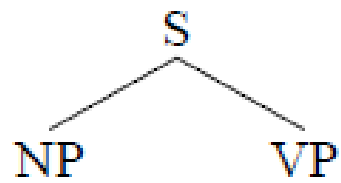
Parsing Strategies

- Top-Down Parsing
- Bottom-Up Parsing

Top-Down Parser

- Builds from the **root S** node to the leaves.
- Find a rule to apply by matching the **left hand side** of a rule.
- Build a tree by **replacing** LHS with the right hand side.
- Assuming we build all trees in parallel:
 - Find **all trees with root S** (or **all rules w/lhs S**).
 - Next **expand** all constituents in these trees/rules.
 - While expansion, replacing the **leftmost non-terminal** with each of its possible expansions.
 - Continue **recursively** until **leaves** are present.
 - Candidate trees **failing** to match. the input string are **rejected** (e.g. **Book that flight can only match subtree 5**).

S



Bottom-Up Parsing

- Parser begins with words of input and builds up trees, applying grammar rules whose **right hand side** match.
- Parse continues until an **S root node** reached or no further node expansion possible.

The word *book* is ambiguous; it can be a noun or a verb

Book that flight

Noun Det Noun
| | |
Book that flight

Verb Det Noun
| | |
Book that flight

NOM NOM
| |
Noun Det Noun
| | |
Book that flight

NOM
|
Verb Det Noun
| | |
Book that flight

NP
/ \
NOM NOM
| |
Noun Det Noun
| | |
Book that flight

VP NOM
| |
Verb Det Noun
| | |
Book that flight

NP
/ \
Verb Det NOM
| | |
Book that flight

VP
/ \
VP NP
/ \
Verb Det NOM
| | |
Book that flight

VP
/ \
Verb Det NOM
| | |
Book that flight

Exercise

“Does this flight include a meal”

- Apply Top-Down and Bottom-Up Parsing to this sentence

What's wrong with....

- **Top-Down parsers** never explore illegal parses (e.g. can't form an S) -- **but** waste time on trees that can never match the input.
- **Bottom-Up parsers** never explore trees inconsistent with input -- **but** waste time exploring illegal parses (no S root).