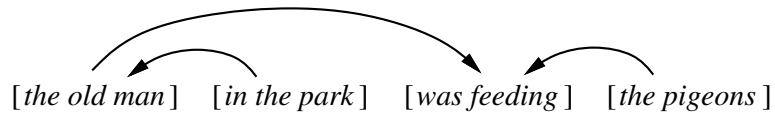

Chunks and Dependencies and Human Sentence Processing

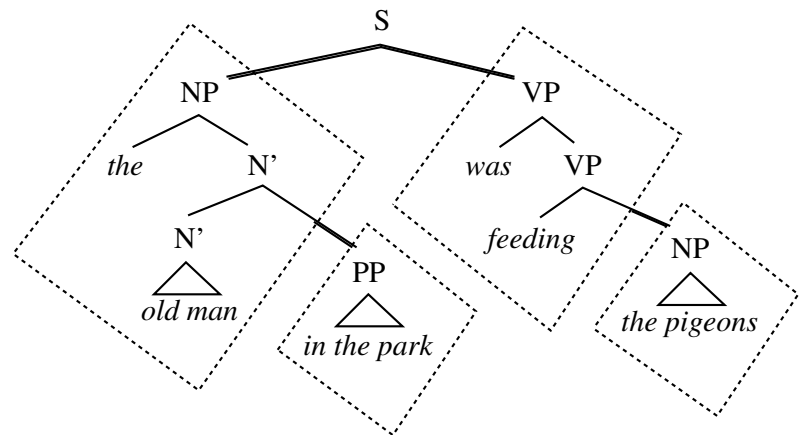
Steven Abney
University of Tübingen

What are Chunks

- Introspection about sentence processing in reading
the old man in the park was feeding the pigeons

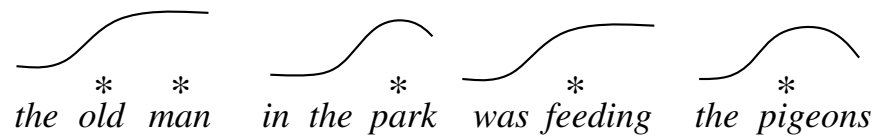


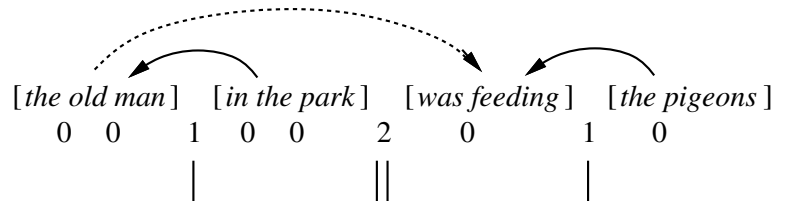
- Not constituents



Whence the Intuition

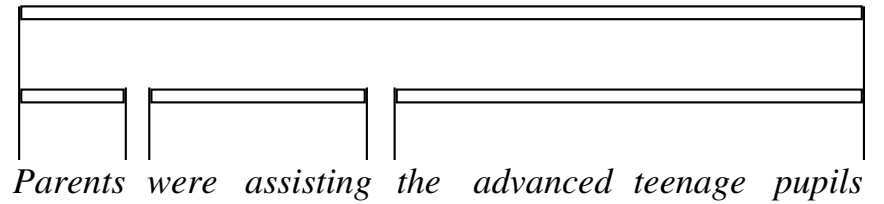
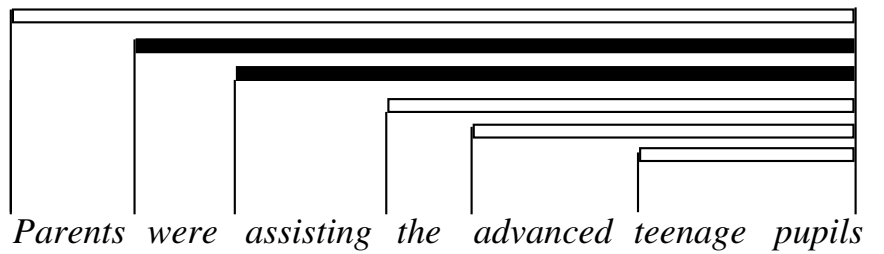
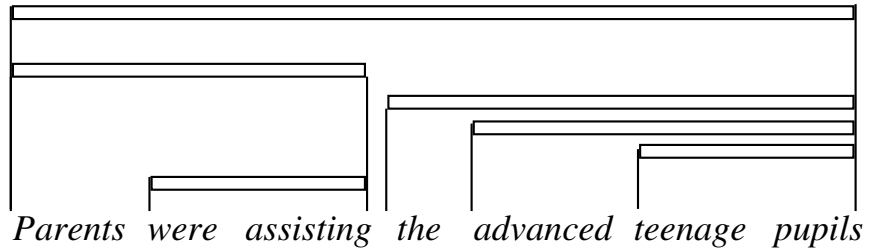
- Prosody


the old man in the park was feeding the pigeons


[the old man] [in the park] [was feeding] [the pigeons]
0 0 1 0 0 2 0 1 0
| || |

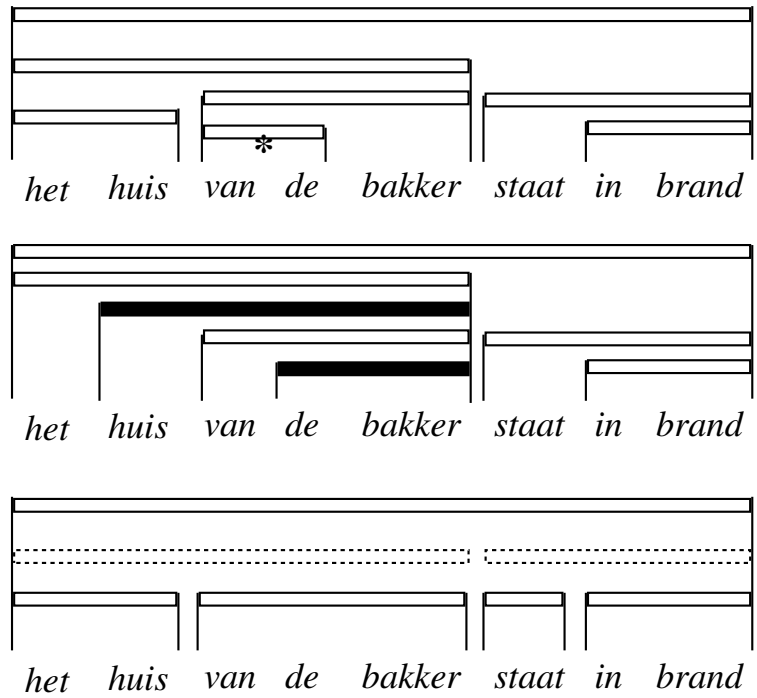
Performance Structures

- Martin 1970—Naive parsing



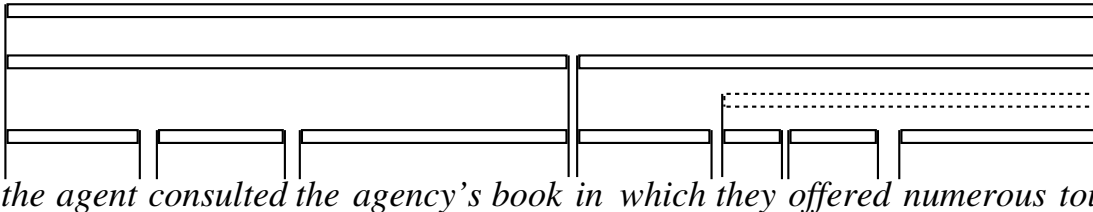
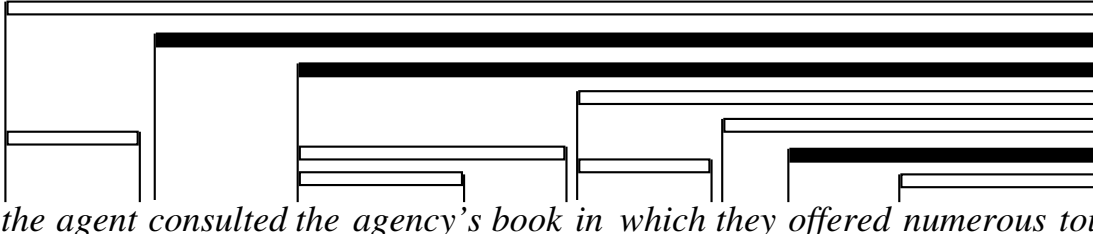
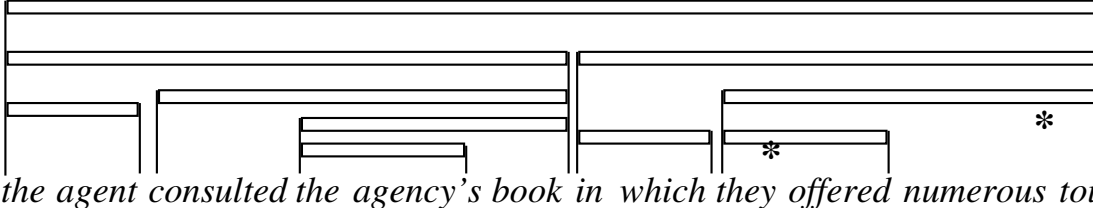
Levelt 1970

- Transition error probabilities



Grosjean, Grosjean and Lane 1979

- Parsing and pausing



Finite-State Cascade

- Regular expressions defining chunks and clauses

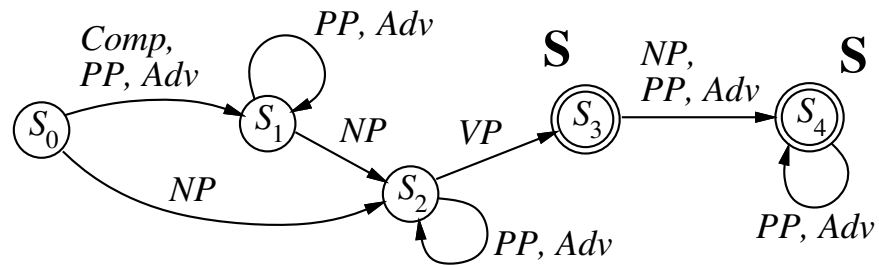
Clause: $S \rightarrow \text{Comp? (PP|Adv)* NP (PP|Adv)* VP NP? (PP|Adv)*}$

Chunk: $\text{NP} \rightarrow \text{Det? Adj* N}$

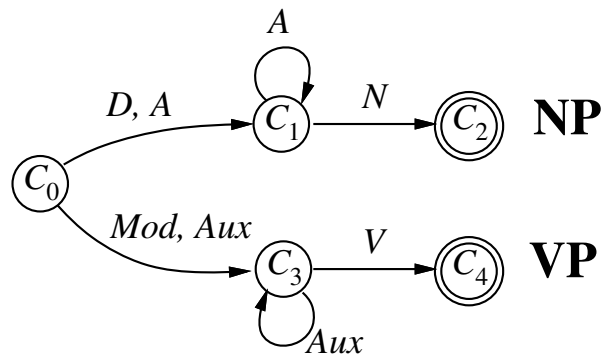
$\text{VP} \rightarrow \text{Mod? Aux* V}$

- Finite-state machines

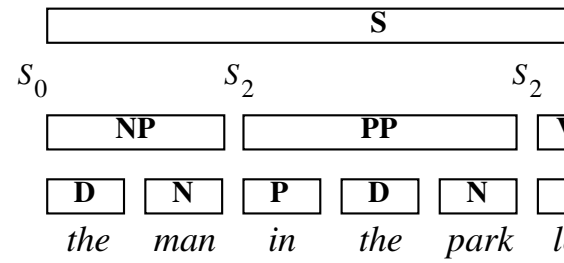
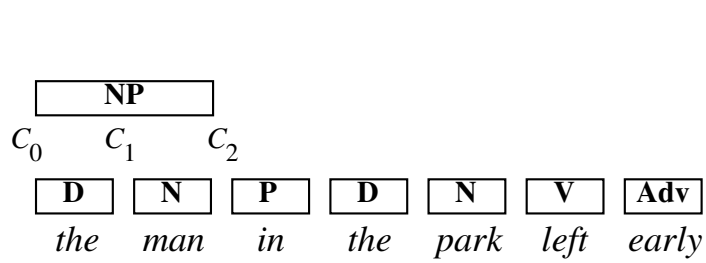
Clause:



Chunk:



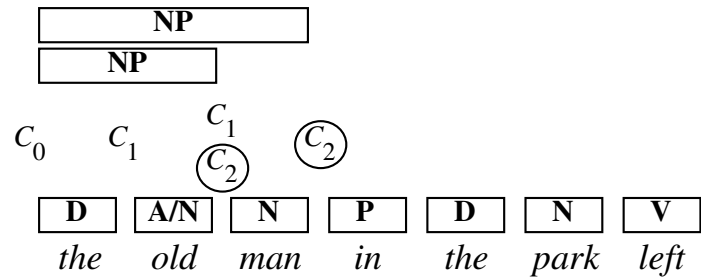
Parsing



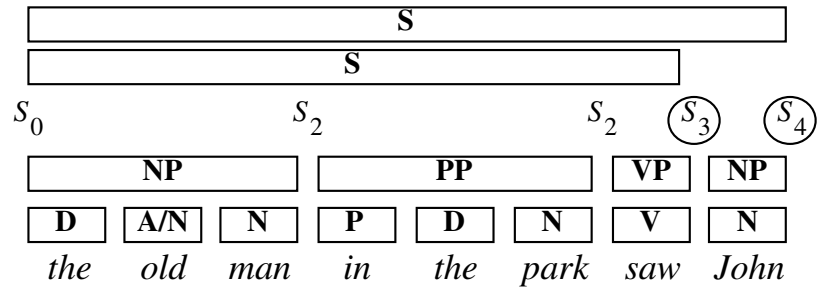
- Longest match within level
 - Punt if no match
 - No center-embedding
 - Special level for nested RC's, participles
-
-

Longest Match

- Chunks:



- Clauses:



Similar to Late Closure

- Chunks:

the emergency crews hate most is domestic violence

- Clause:

because John always jogs a mile seems short to him

- Compounds:

a hundred pound bags

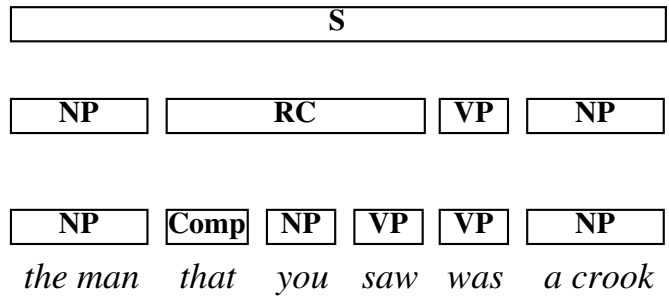
Effectiveness

- Corpus data
- Hand tagged
- Disambiguate via longest match at each level, punt if no match
- Effectiveness

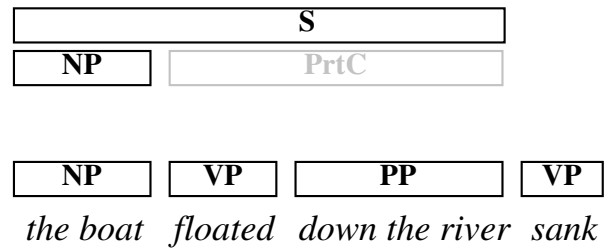
	recall	precision
chunks:	96%	91%
NP's:	92%	87%

Nested Relative Clauses

- Nested relative clause



- Bever 1970



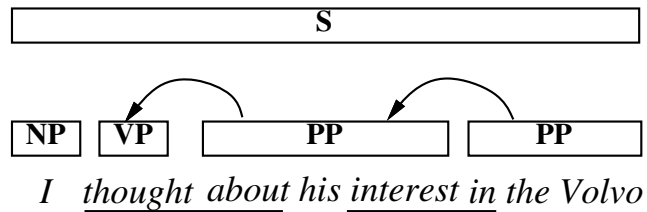
Attachment

- Lexical head-head associations

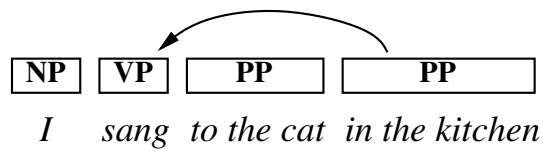
- Attachment preferences:

Attach as argument (left)
Attach to (anticipated)
Attach to nearest site

- Argument:

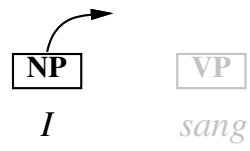


- Head:

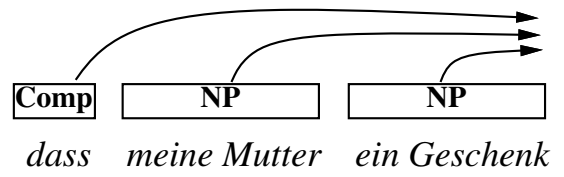


Anticipated Head

- Subject:



- Head-final (German):

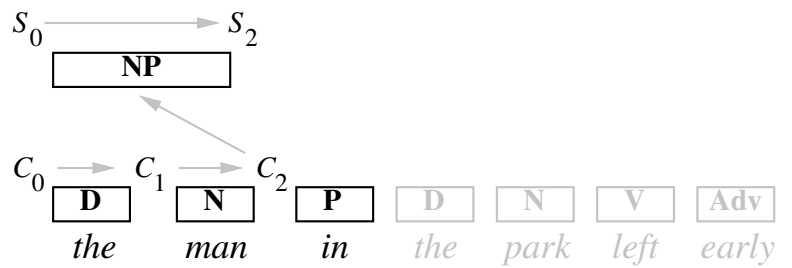


Plausibility of Time Course

- Level-by-level is completely implausible

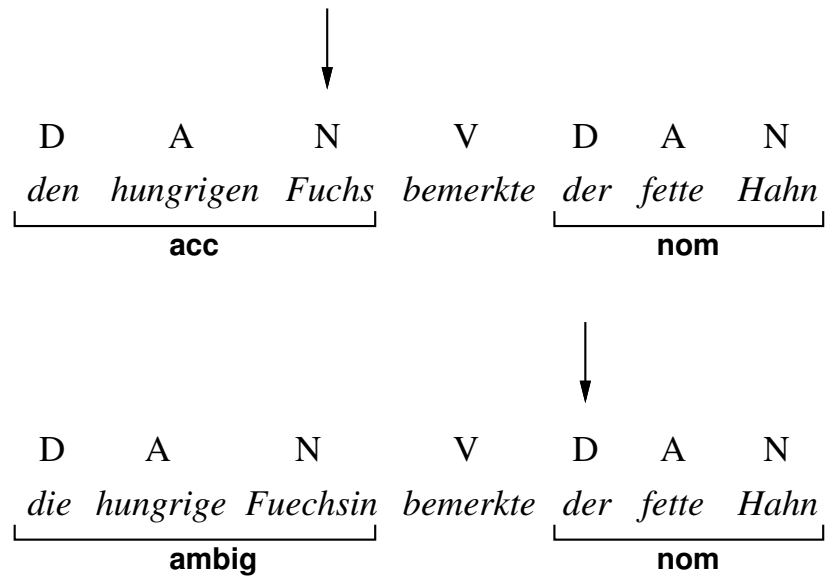
I think Bill said Mary left

- One pass is no problem



Hemforth, Konieczny, and Strube

- Slow-down in reading and decision times when it is realized that order is C



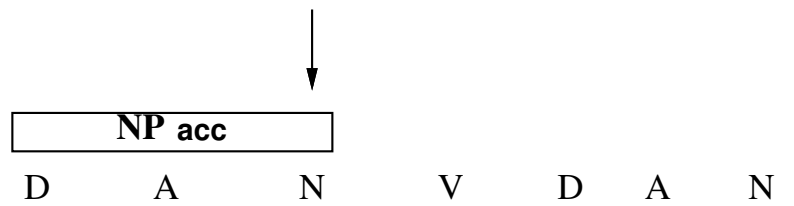
- Slow-down is relative to:

nom	V	acc
nom	V	ambig
ambig	V	acc
ambig	V	ambig

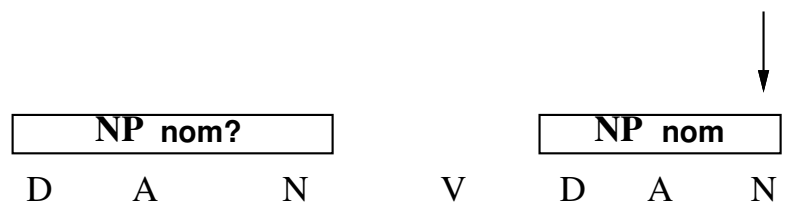


Problem for Chunking

- OK:



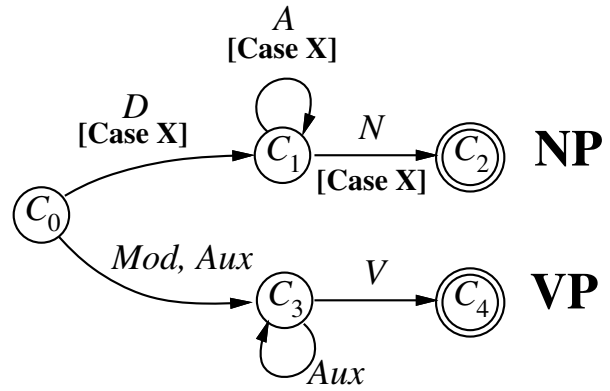
- But: if case anomaly not recognized till NP is constructed:



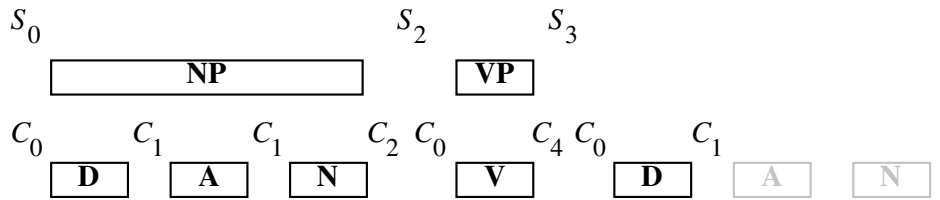
Finer-Grained Alternative

- Case features are unified when arc is transversed:

den



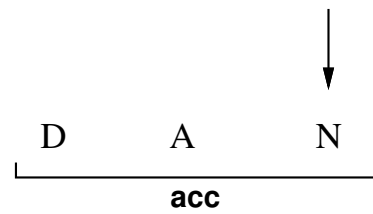
- Assumption: expectation [Case \neg nom] from S_3 is available to chunk state



- Phrase construction = commitment. GP if wrong.

Left Corner

- Why delayed slowdown for first NP?

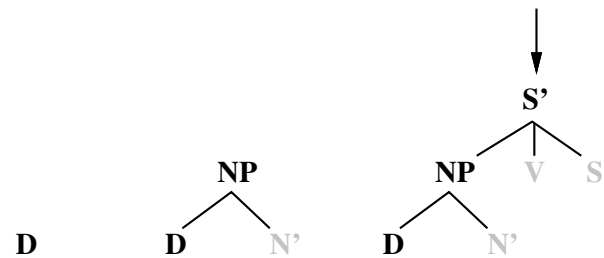


- Hemforth et al.: Left-corner parsing
- Chunk analogue: levels started on demand



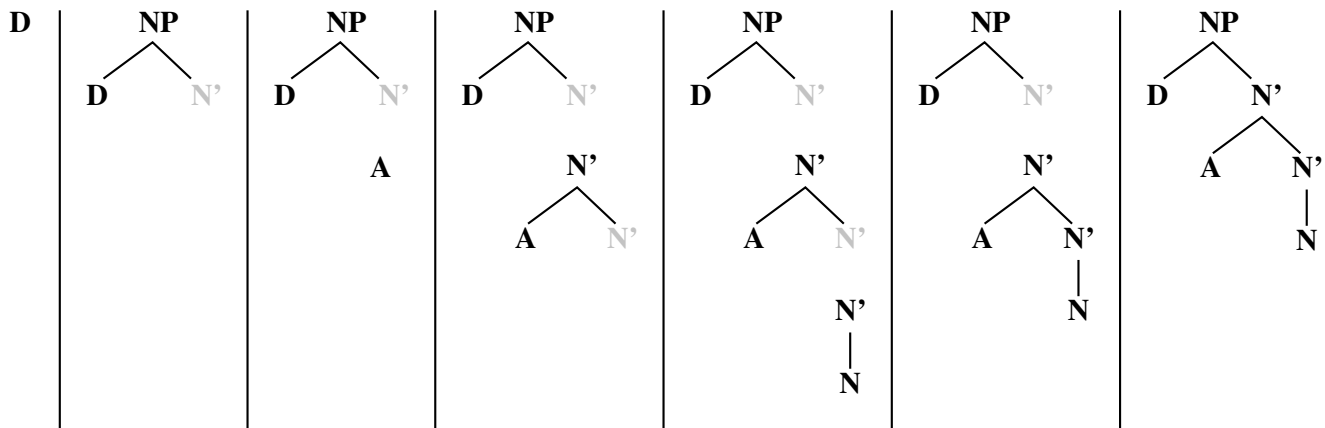
Problem for Left Corner

- Left-corner, arc-standard: create parent and predict sisters, but don't attach
- Left-corner, arc-eager: attach parent to grandparent as soon as parent is created
- Eager is too eager:



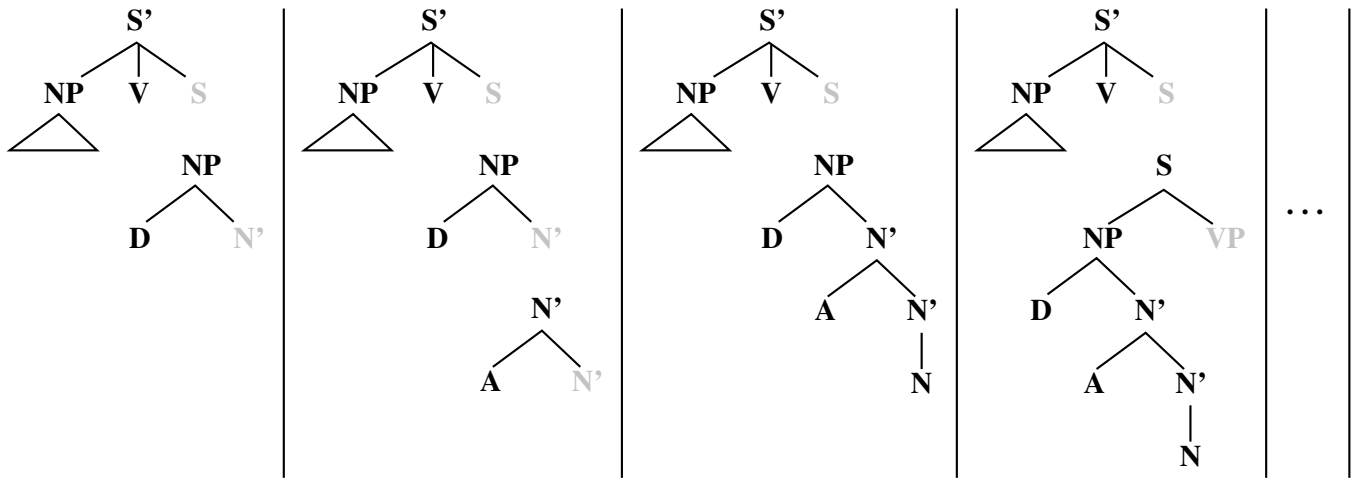
Left-Corner, Arc-Standard

- Makes right predictions for first NP

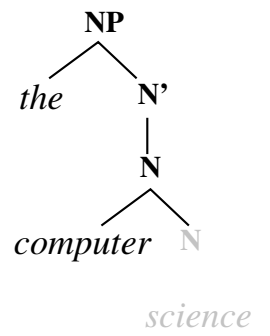
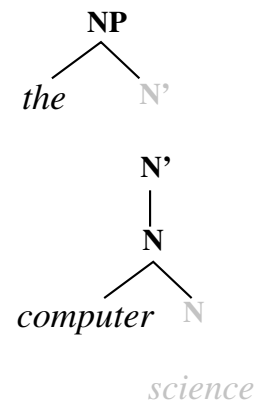
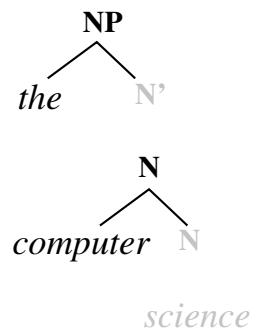
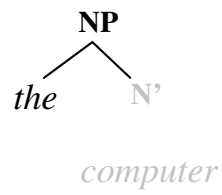
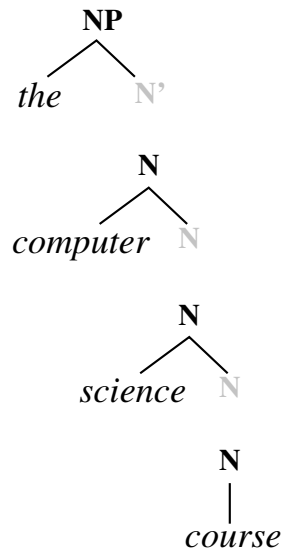
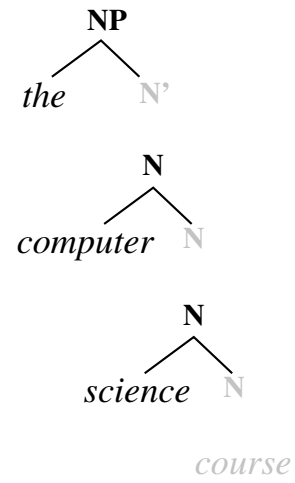
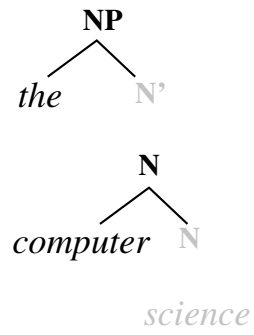
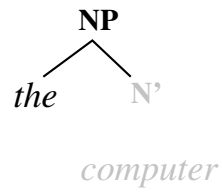


Left-Corner, Arc-Standard

- Makes wrong predictions for second NP

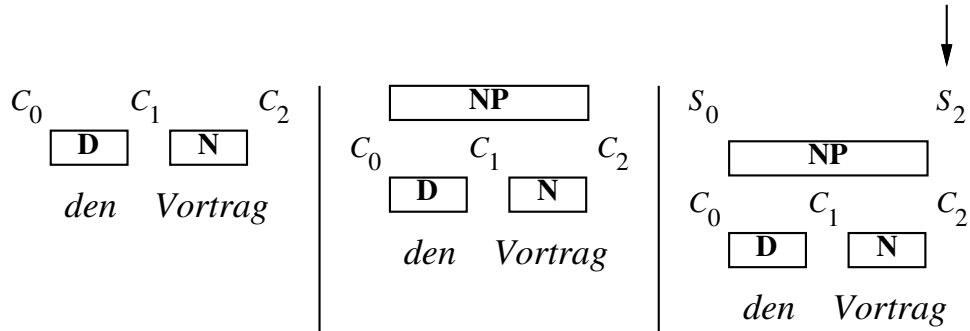


Not Just a Technicality



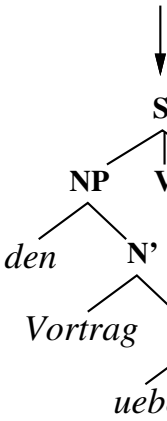
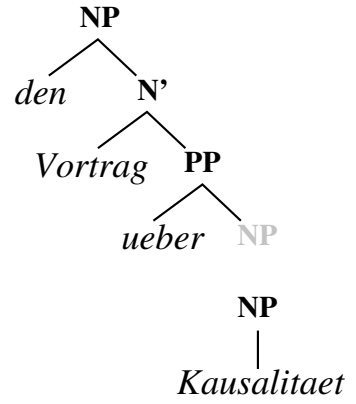
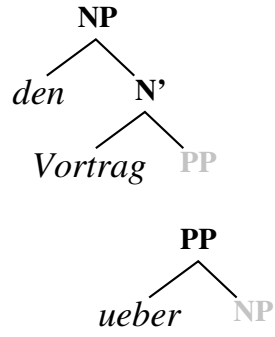
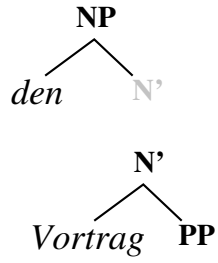
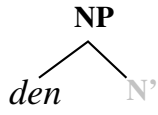
Discriminating Hypotheses

- Mixed LC: arc-standard if stack is empty, else arc-eager
- ‘Interactive’ chunk model and Mixed LC both get Hemforth et al. data right
- Different predictions on multi-chunk first NP’s



Multi-Chunk NP

- Mixed LC:



Summary

- Chunks & dependencies: finite-state cascade, attachment within levels
 - Longest match disambiguates chunks
 - Corpus evaluation
 - Addressing incrementality:
 - Levels on demand
 - Feature expectations from context, unified during transitions
 - Only mixed LC consistent with Hemforth et al. data
 - Differing predictions on multi-chunk NP's
-
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