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Dependency Parsing with Multiword Expressions

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Uppsala University

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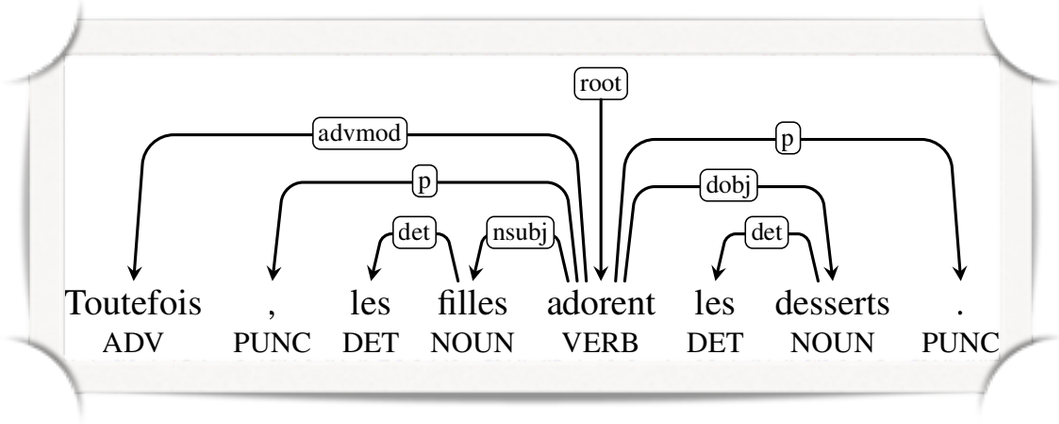
Introduction

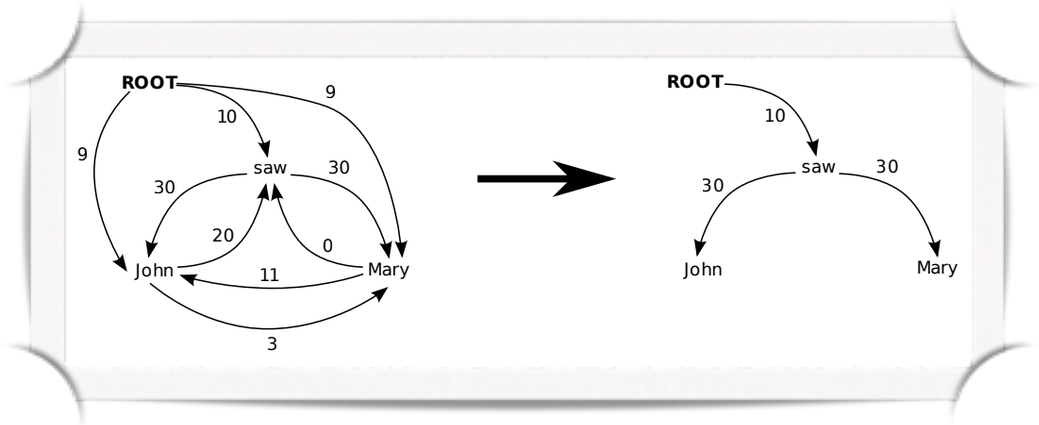
- Statistical dependency parsing
  - Map sentences to dependency trees
  - Learn mapping from (labeled) corpora



- Approaches
  - Graph-based: scoring function for trees, factored into subgraphs
  - Transition-based: scoring function for derivations, factored into transitions
- Recent convergence
  - Globally normalized models for structured prediction (perceptron style)
  - Rich features over the dependency tree (higher-order models)
  - Approximate search (beam search, dual decomposition, cube pruning)

Representations

- The spanning tree assumption:
  - Input is a sequence of tokens
  - Output is a directed spanning tree



- Problematic in two ways
  - A tree may not be sufficient to represent syntactic structure
  - There may not be a 1:1 mapping from tokens to nodes
    - French *du* = *de le* (1:*m*)
    - French *à cause de* = *à-cause-de* (*m*:1)
    - French *à cause du* = *à-cause-de le* (*m*:*n*)

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This talk

- Giving up the spanning tree assumption
- Annotated resources
  - The Uni-Dep-TB project
- Parsing techniques
  - Transition-based model for parsing with MWEs

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Uni-Dep-TB

- Treebank annotation schemes vary across languages
  - Hard to compare parsing results across languages (Nivre et al., 2007)
  - Hard to evaluate cross-lingual learning (McDonald et al., 2013)
- Recent initiatives:
  - HamleDT: Conversion of 29 existing treebanks to a PDT-like annotation scheme (Zeman et al., 2012)
  - Universal Dependency Treebank Project: New annotation, conversion and harmonization towards a cross-linguistically consistent annotation scheme (McDonald et al., 2013)

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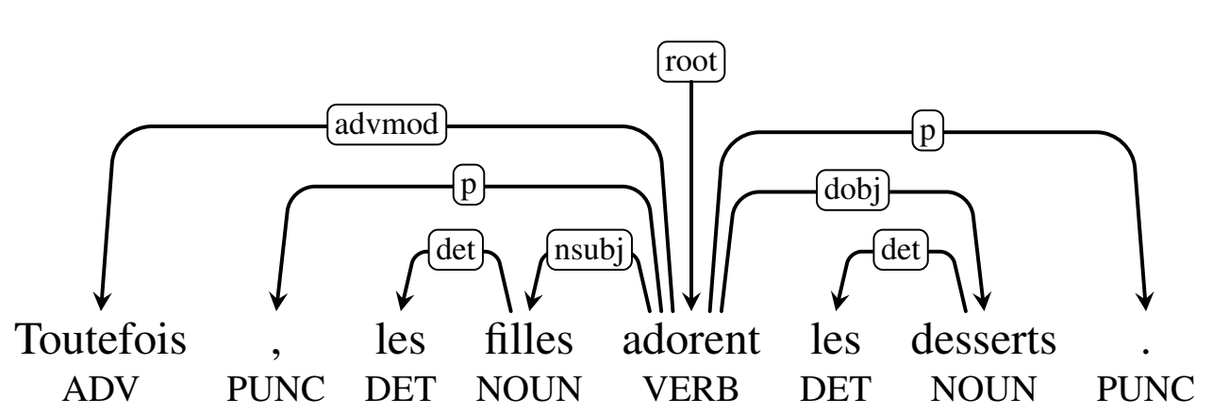
Uni-Dep-TB

https://code.google.com/p/uni-dep-tb/



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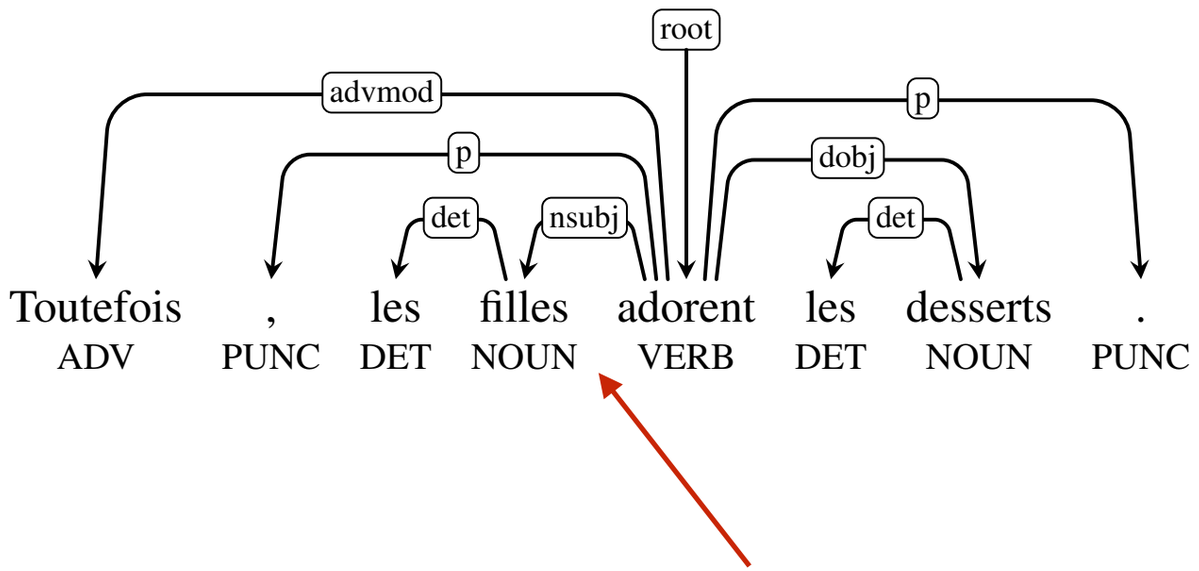
ADJ
ADP
ADV
CONJ
DET
NOUN
NUM
PRON
PRT
VERB
X
.



Google part-of-speech tags (Petrov et al, 2012), fine-grained language specific tags if available

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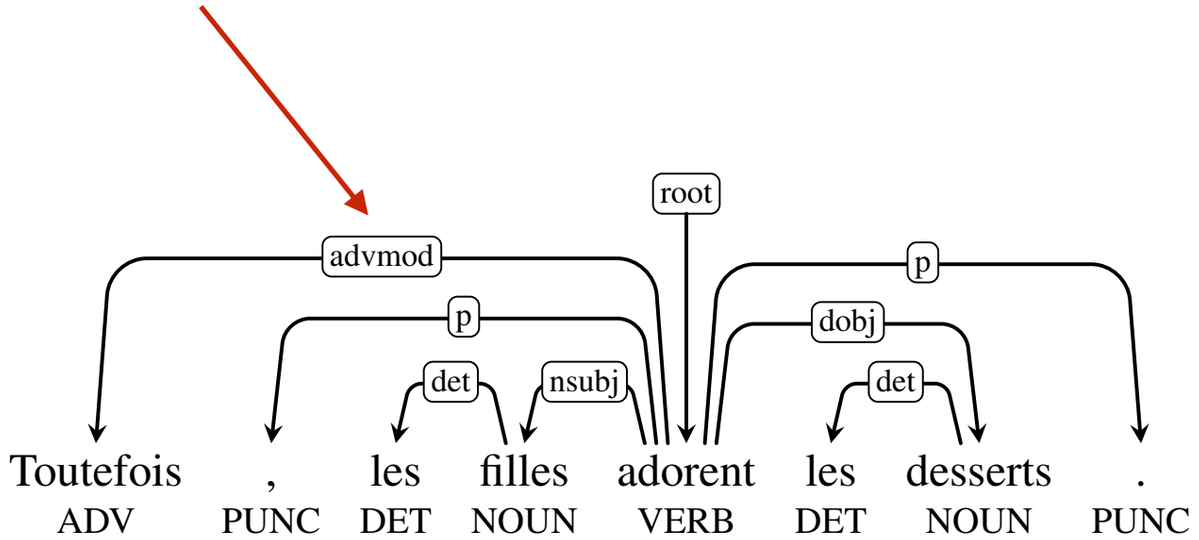
Stanford dependencies (de Marneffe et al, 2006), adapted and harmonised for cross-lingual consistency



acomp	det
adp	dobj
adpcomp	expl
adpmod	infmod
adpobj	iobj
advcl	mark
advmod	mwe
amod	neg
appos	nmod
attr	nsubj
aux	nsubjpass
auxpass	num
cc	p
ccomp	parataxis
compmod	partmod
conj	poss
cop	prt
csubj	rcmod
csubjpass	rel
dep	xcomp

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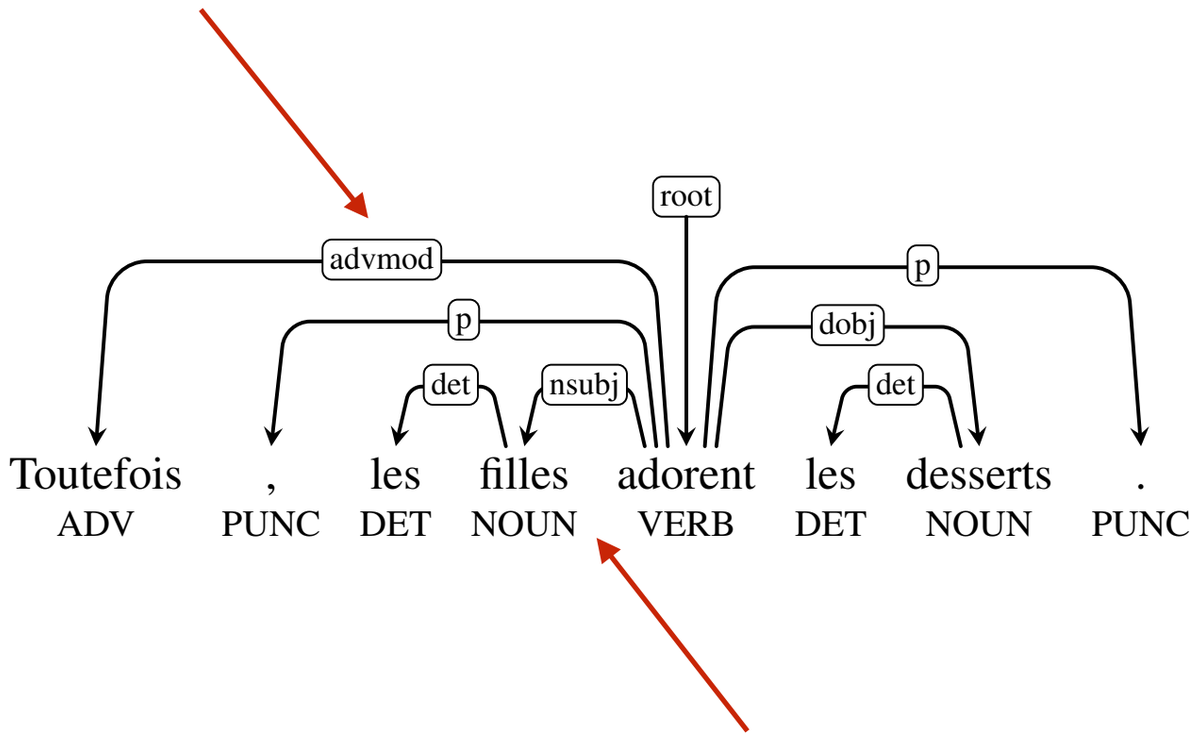

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Version 1.0:
English
French
German
Korean
Spanish
Swedish
July 2013

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Uni-Dep-TB

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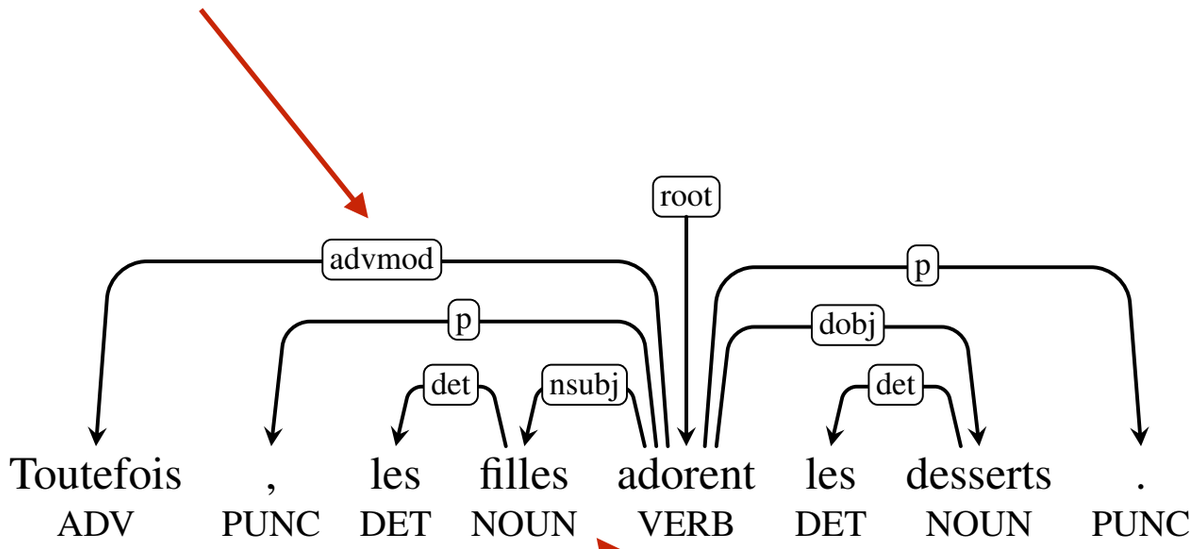
Version 2.0:
English
Finnish
French
German
Italian
Indonesian
Japanese
Korean
Portuguese
Spanish
Swedish
February 2014

Version 1.0:
English
French
German
Korean
Spanish
Swedish
July 2013



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Problems and Prospects

- Treebanks still satisfy the spanning tree assumption
  - For MWEs, the mwe relation can be used to annotate pseudo-dependencies — but no consistent guidelines
  - No consistent principles for segmenting contractions, clitics, etc.
- Recent initiative
  - Dagsthuhl seminar on MT for morphologically rich languages
  - Working group on extending the Uni-Dep-TB scheme

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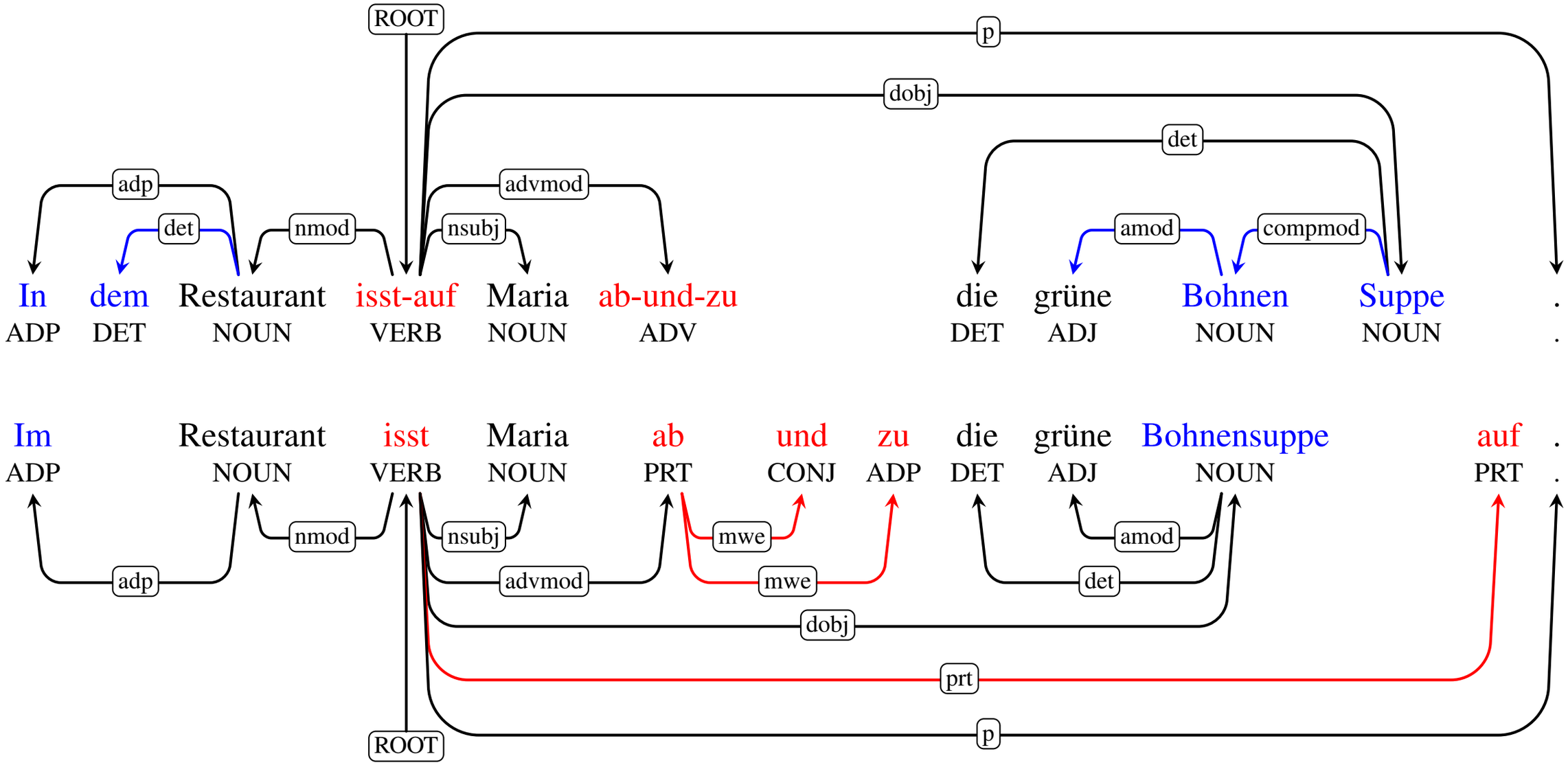
Dagstuhl Proposal



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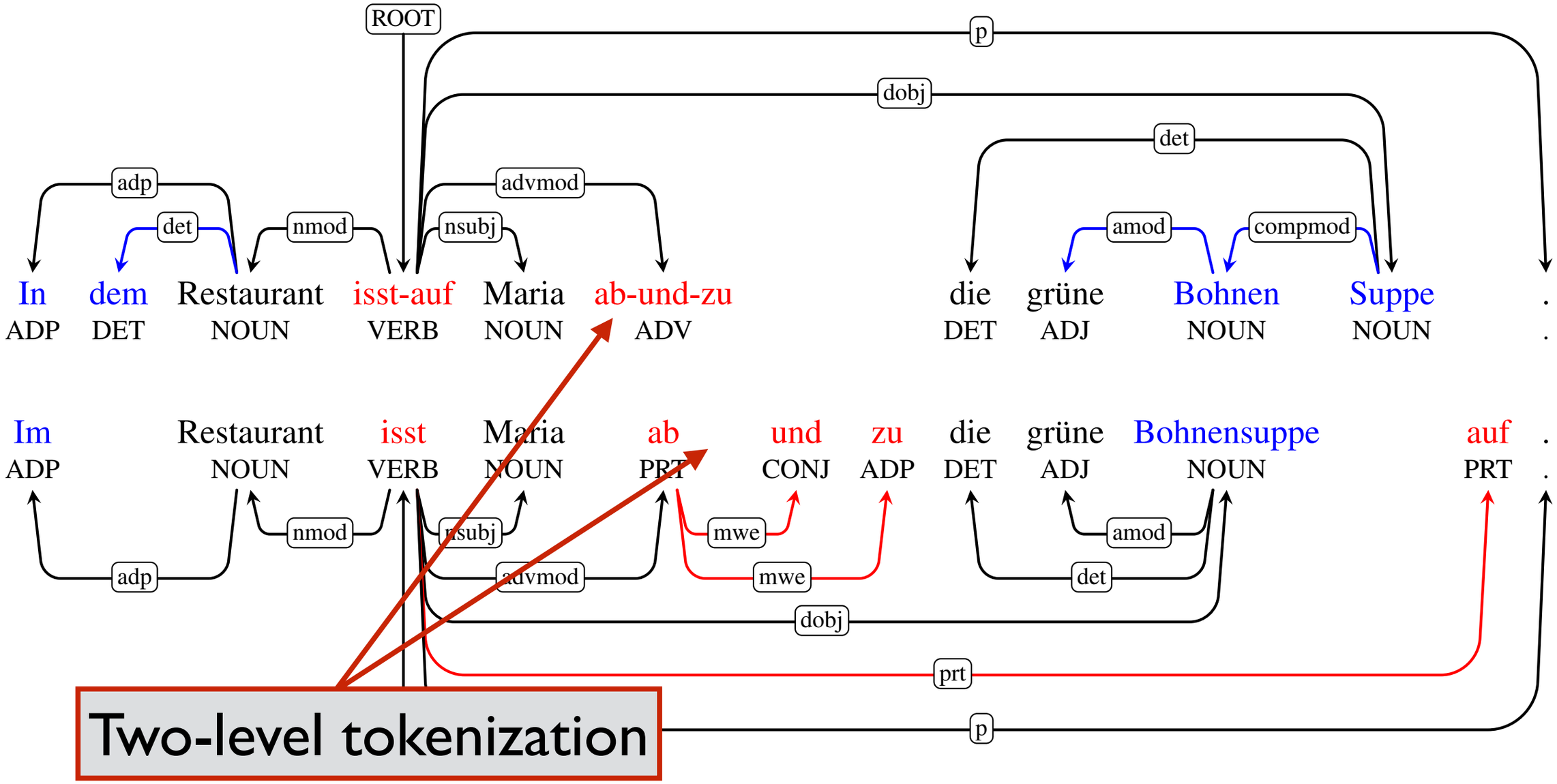

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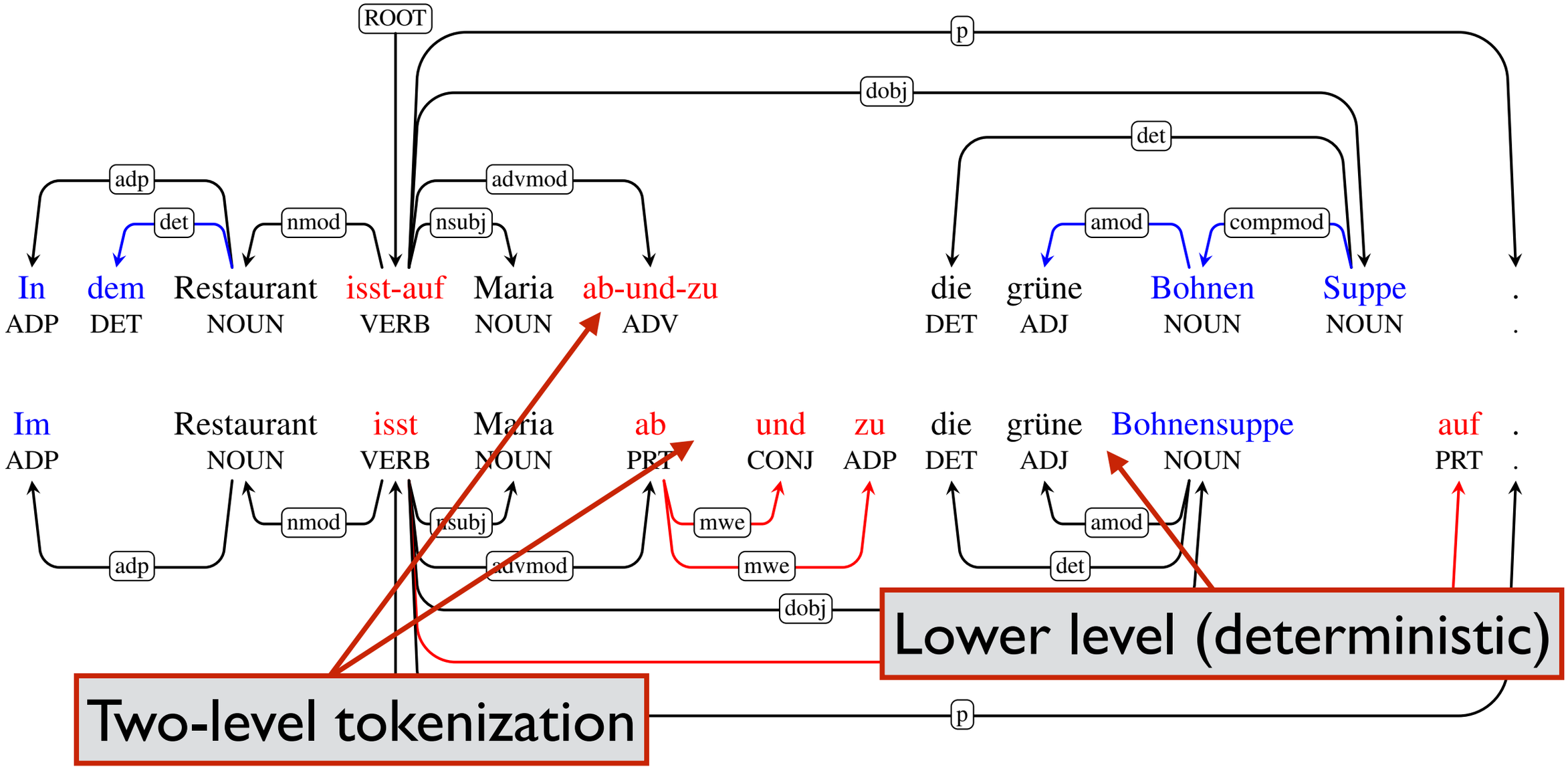

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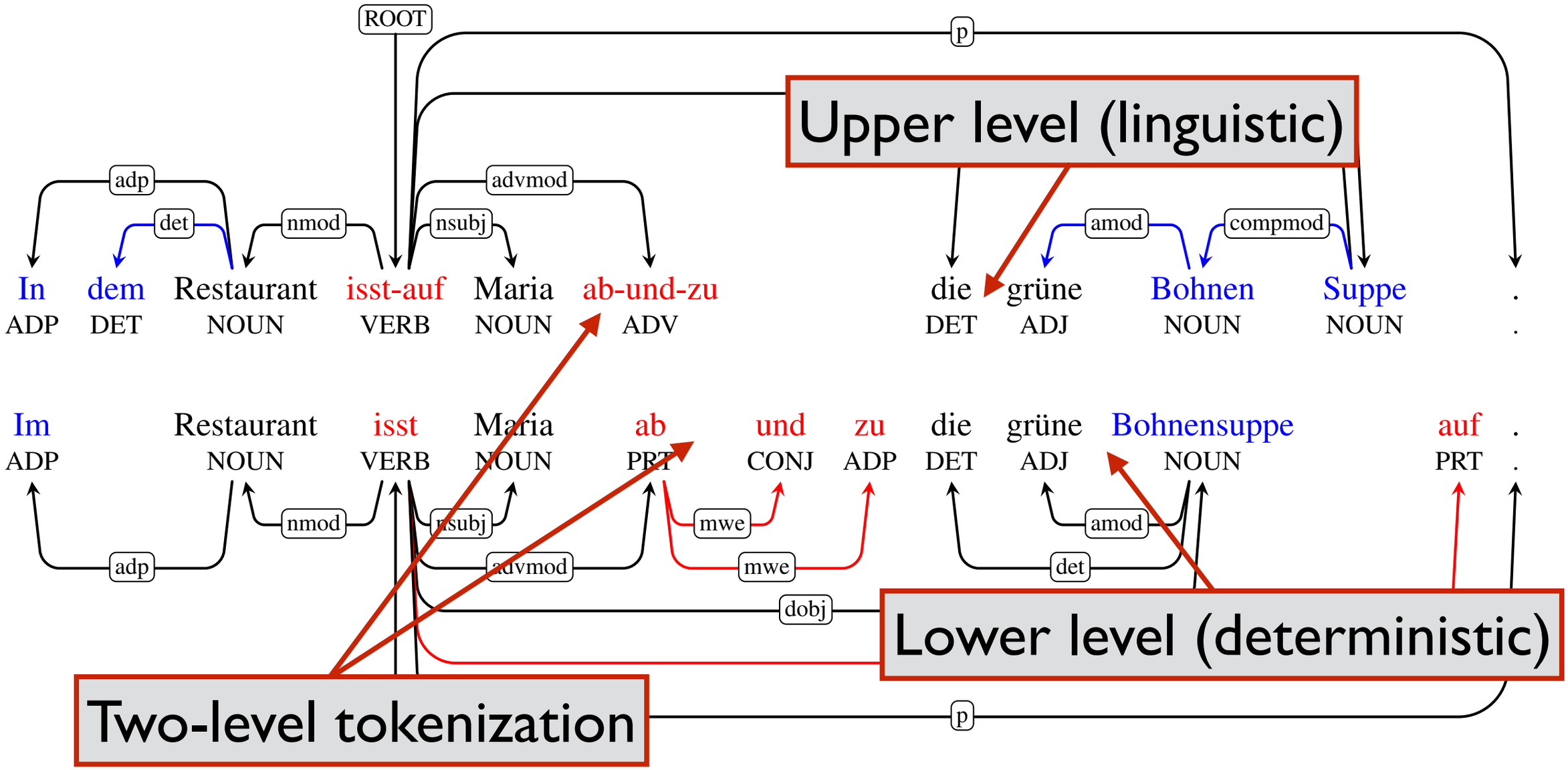

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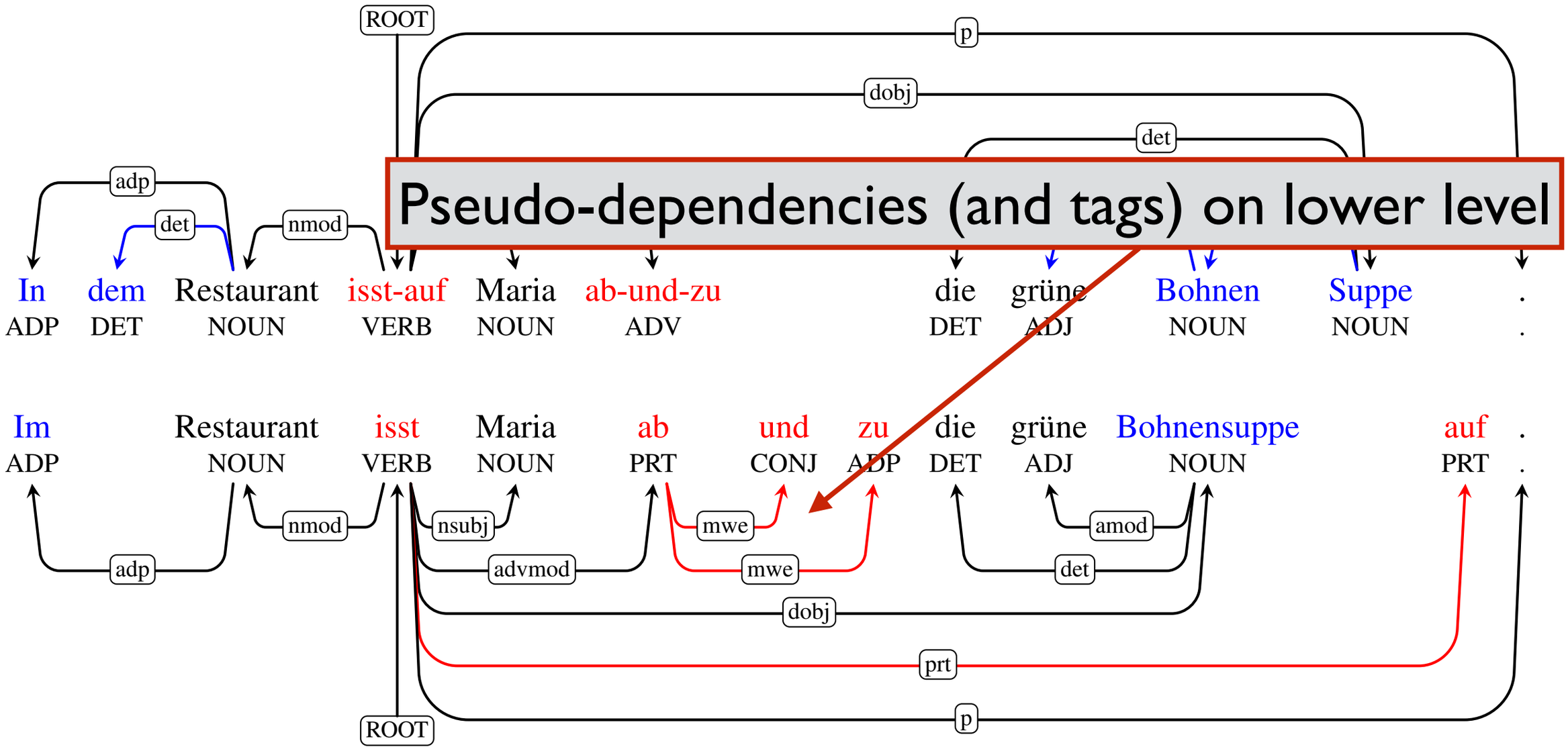

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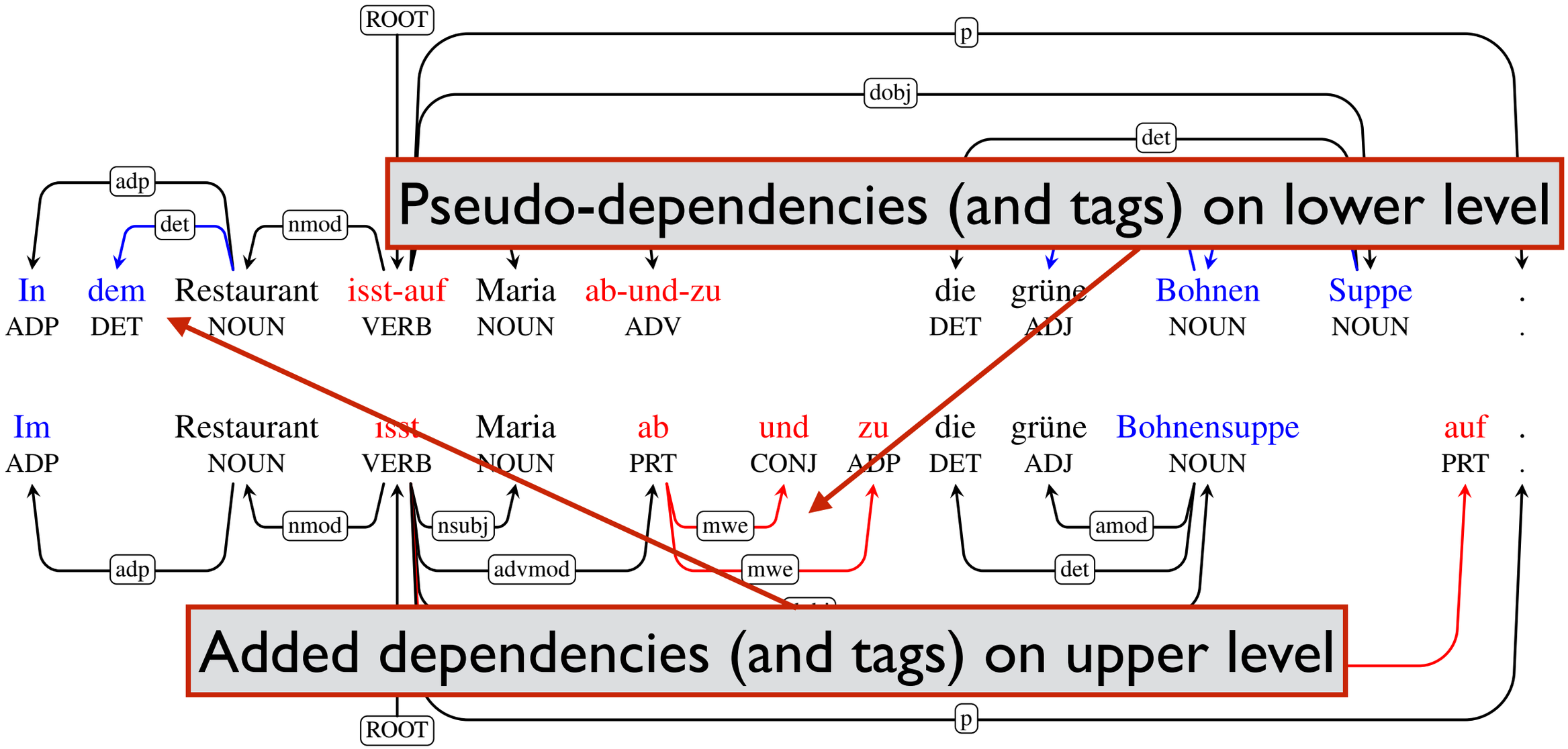

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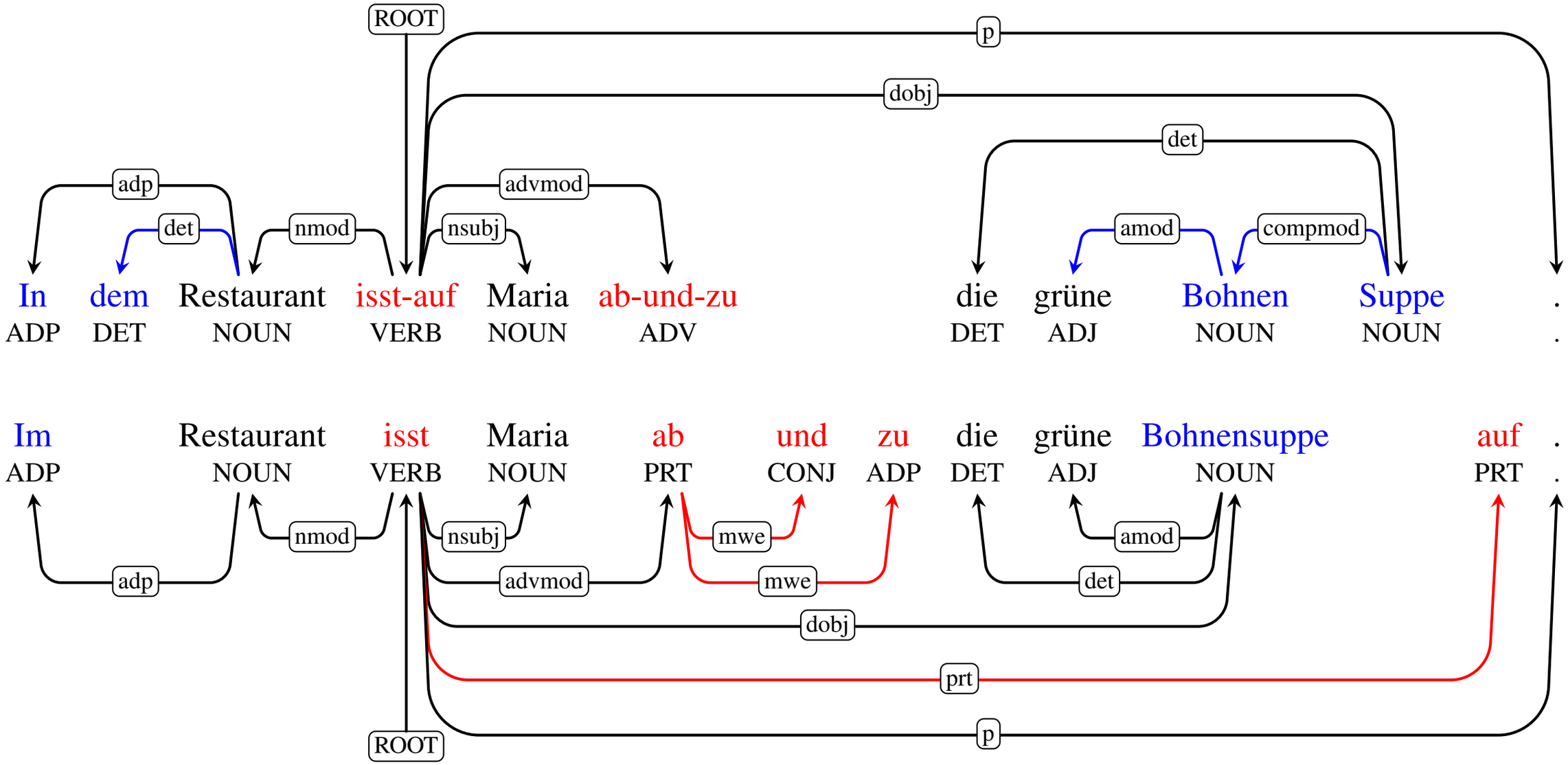

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Outlook

- Two-level tokenization adds flexibility (and usefulness)
  - If you want to continue playing the treebank game, ignore lower level
  - If you want to build robust applications, ignore upper level
  - If you want to handle all linguistic phenomena, use both
- The way forward
  - No annotated resources exist in this format yet
  - Uni-Dep-TB is meant to be a community effort
  - Any volunteers?

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Transition-Based Parsing

- Transition system
  - Abstract state machine for mapping sentences to dependency trees
  - Configurations = parser states
  - Transitions = parser actions
- Scoring model
  - Statistical model for scoring possible transitions out of a configuration
  - Usually a linear model learned from treebank derivations
- Search algorithm
  - Algorithm for finding the highest scoring sequence of transitions
  - Usually approximate search (greedy search, beam search)

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Arc-Standard System

- Configurations
  - A buffer B of input tokens
  - A stack S of tree nodes
  - A set of A dependency arcs

node = token

Shift:	$(S, w\|B, A)$	$\Rightarrow$	$(S\|w, B, A)$
Right-Arc:	$(S\|w\|w', B, A)$	$\Rightarrow$	$(S\|w, B, A[w \rightarrow w'])$
Left-Arc:	$(S\|w\|w', B, A)$	$\Rightarrow$	$(S\|w', B, A[w' \rightarrow w])$

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Parsing Example

she	found	the	word

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Parsing Example

she

found | the | word

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Parsing Example

she found

the word

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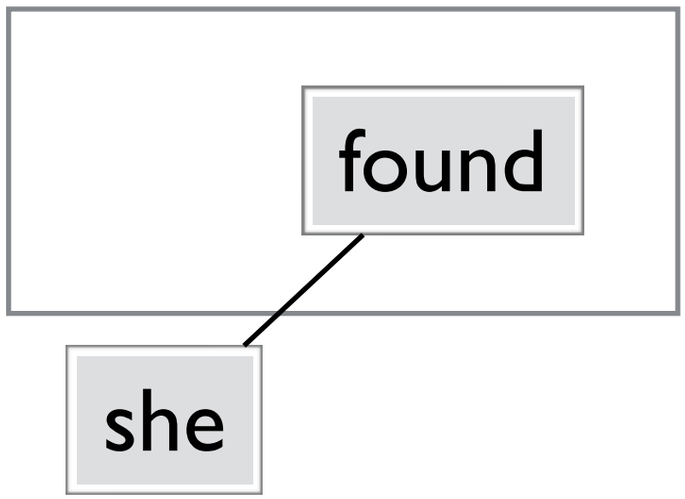
Parsing Example



the word

Parsing Example

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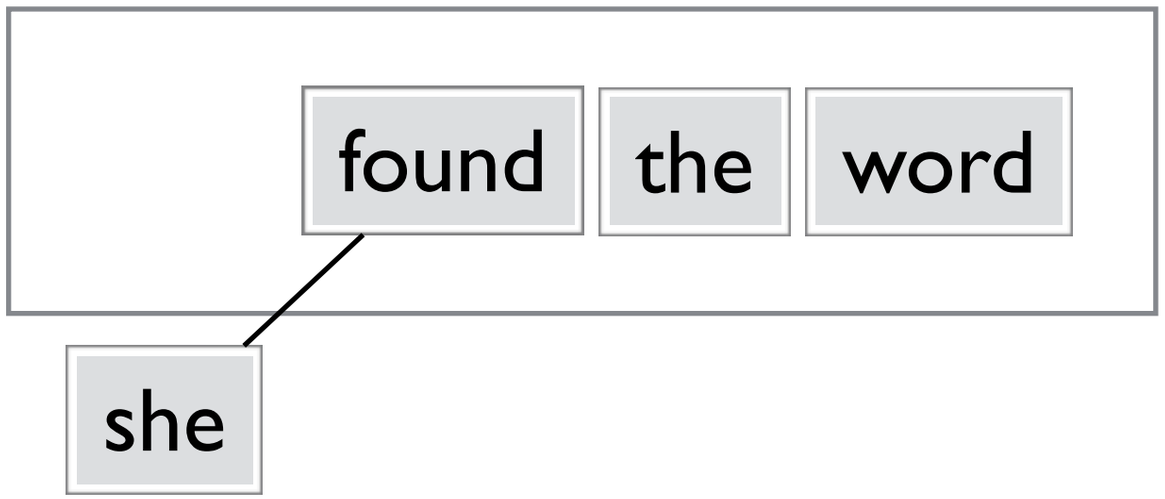

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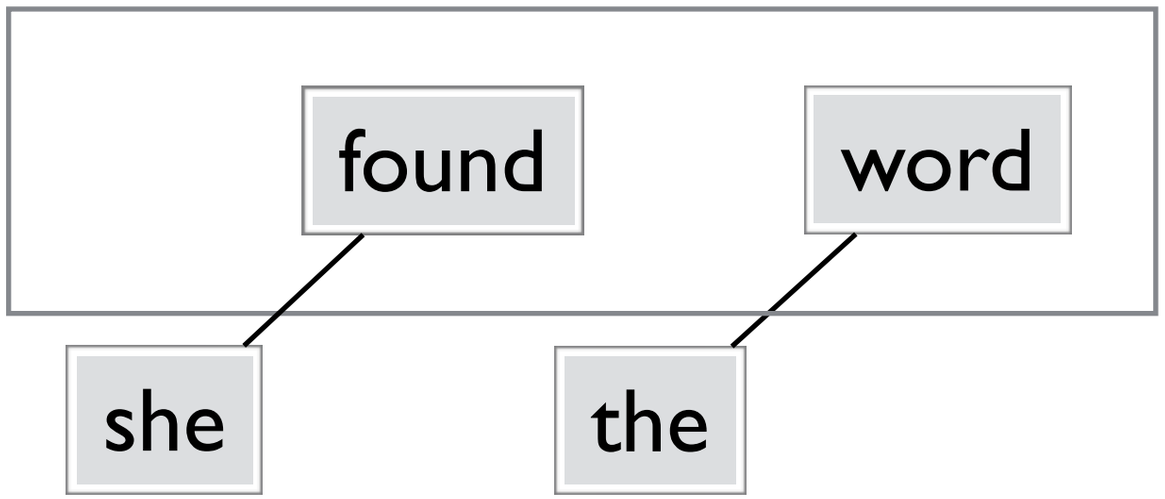

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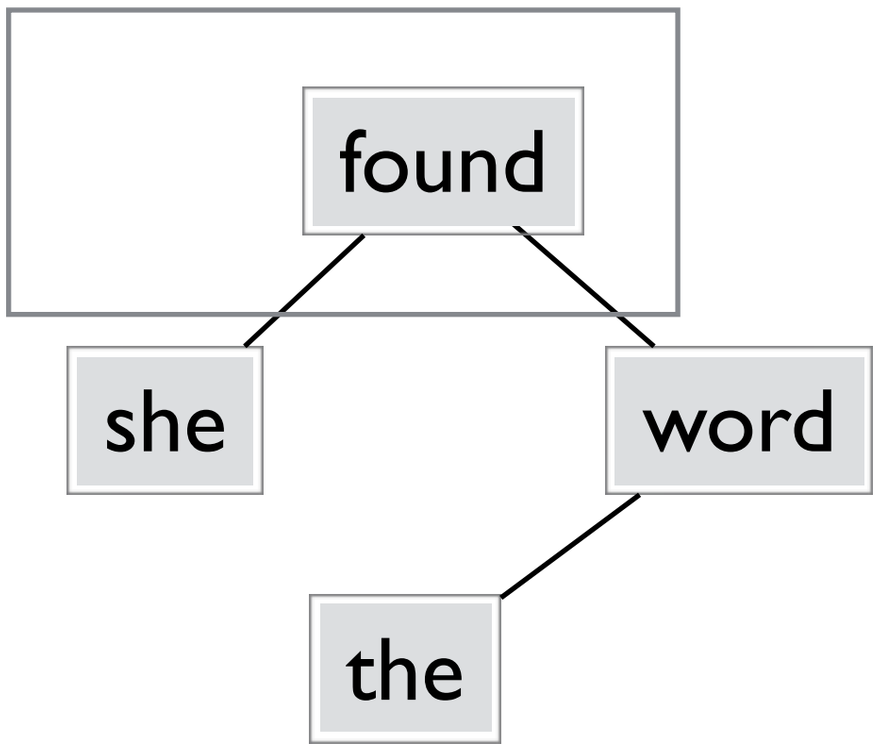

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What about MWEs?

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- MWEs can be handled in preprocessing
  - Only works (well) for fixed, unambiguous expressions

by-and-large

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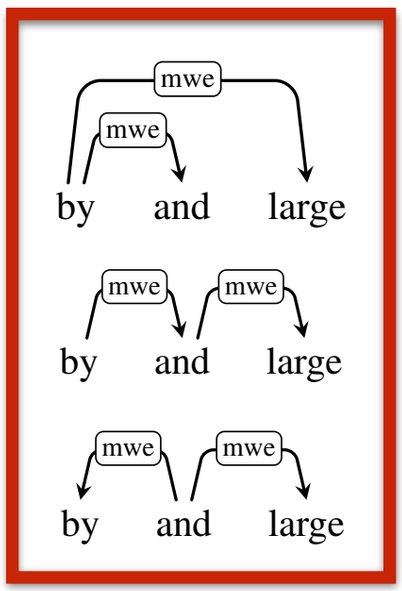
- MWEs can be encoded with pseudo-dependencies
  - Structure is (sometimes) arbitrary
  - Lexical and grammatical features are distorted



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by-and-large

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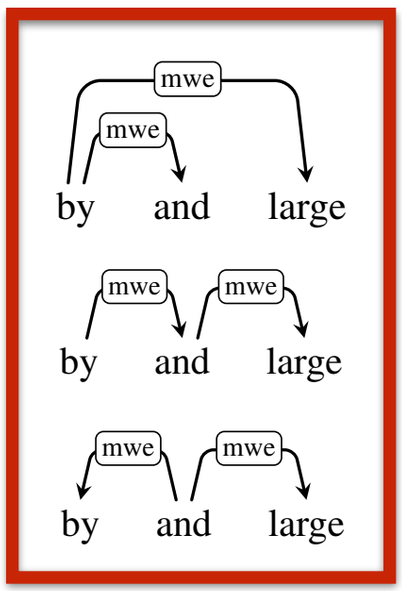
Nivre and Nilsson (2004)	MWE	Other
Oracle preprocessing	100.0	81.6
Pseudo-dependencies	71.1	80.7



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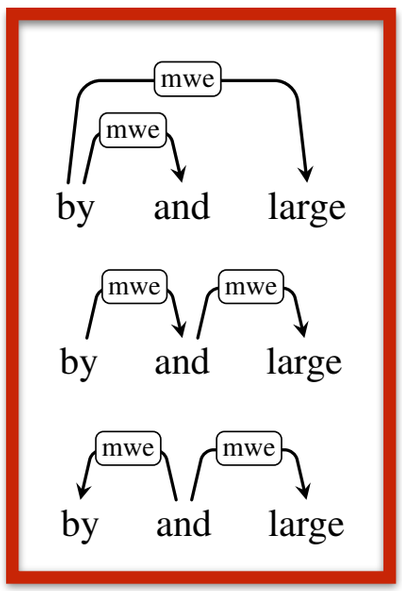

- Can we do better?
  - Make MWEs first class citizens in parsing land
  - Add transition for merging tokens into MWEs

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New Transition System

- Configurations
  - A buffer B of input tokens
  - A stack S of tree nodes
  - A set of A dependency arcs

node = string of tokens

Shift:	$(S, w\|B, A)$	$\Rightarrow$	$(S\|w, B, A)$
Chunk:	$(S\|w\|w', B, A)$	$\Rightarrow$	$(S\|w\text{-}w', B, A)$
Swap:	$(S\|w\|w', B, A)$	$\Rightarrow$	$(S\|w', w\|B, A)$
Right-Arc:	$(S\|w\|w', B, A)$	$\Rightarrow$	$(S\|w, B, A[w \rightarrow w'])$
Left-Arc:	$(S\|w\|w', B, A)$	$\Rightarrow$	$(S\|w', B, A[w' \rightarrow w])$

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Parsing Example 1

she	looked	up	the	word

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Parsing Example 1

she

looked | up | the | word

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Parsing Example I

she looked

up the word

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Parsing Example 1

she | looked | up

the | word

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Parsing Example 1

she | looked-up

the | word

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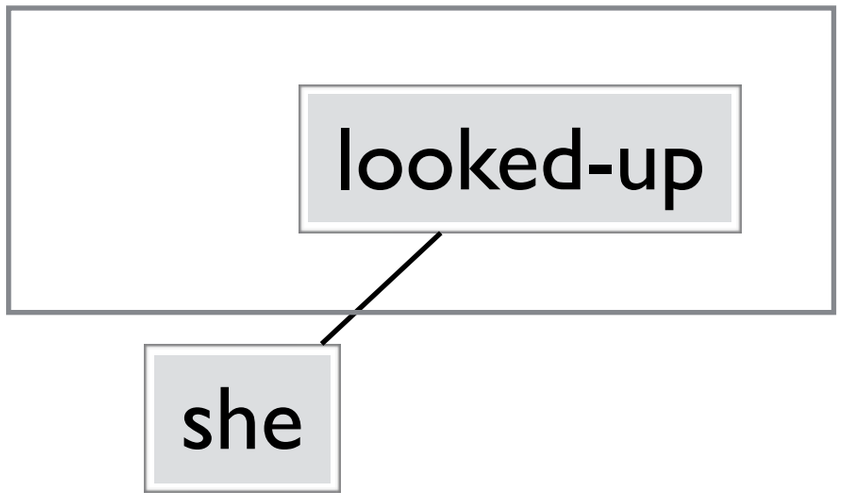
Parsing Example 1



the word

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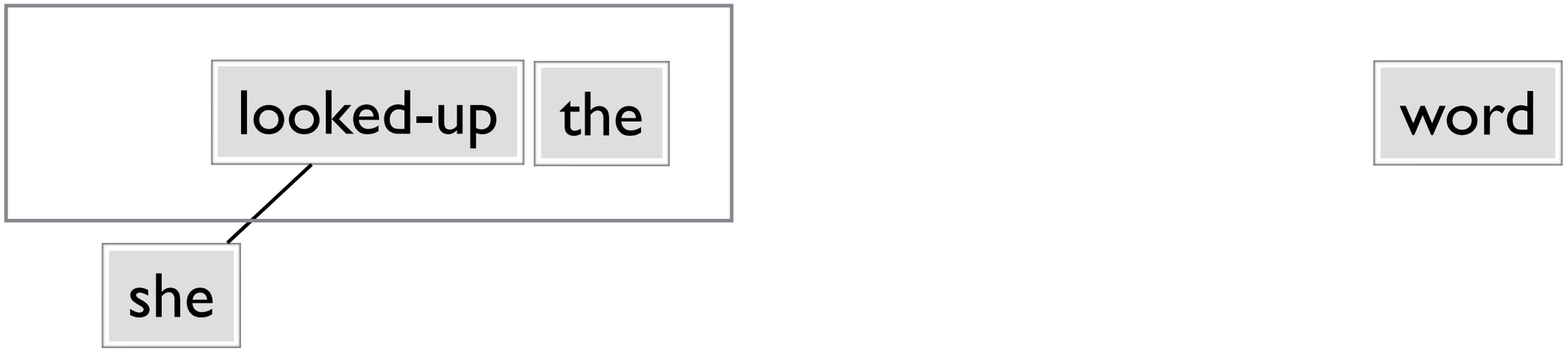
Parsing Example 1



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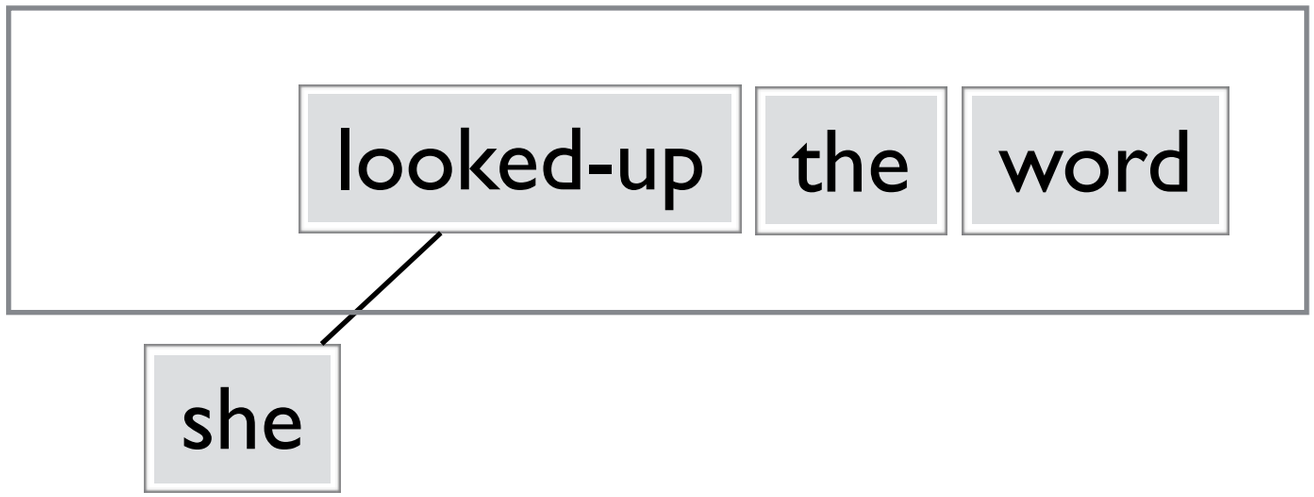
Parsing Example 1



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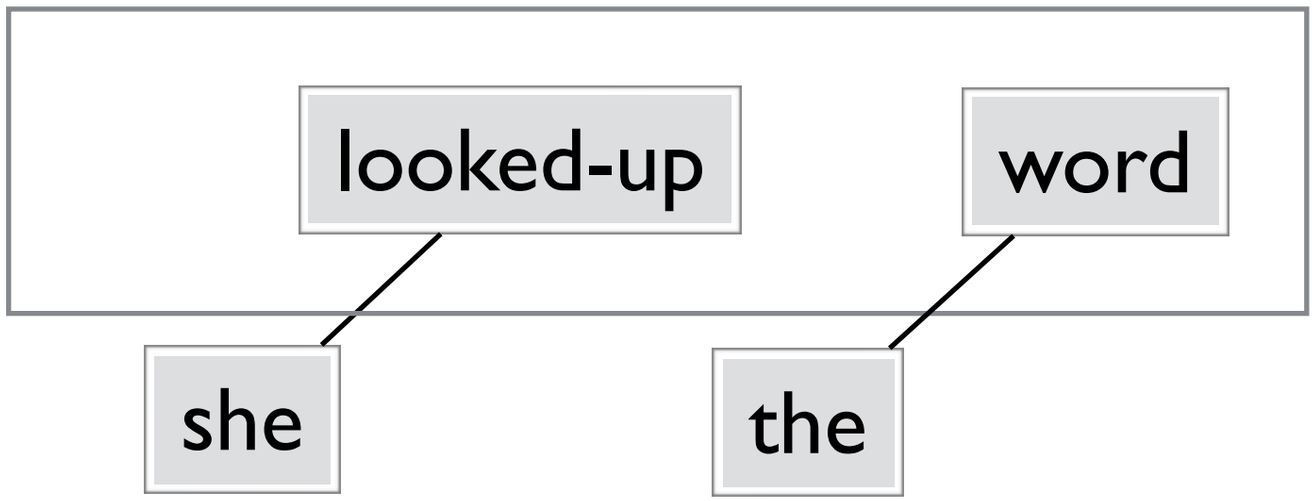

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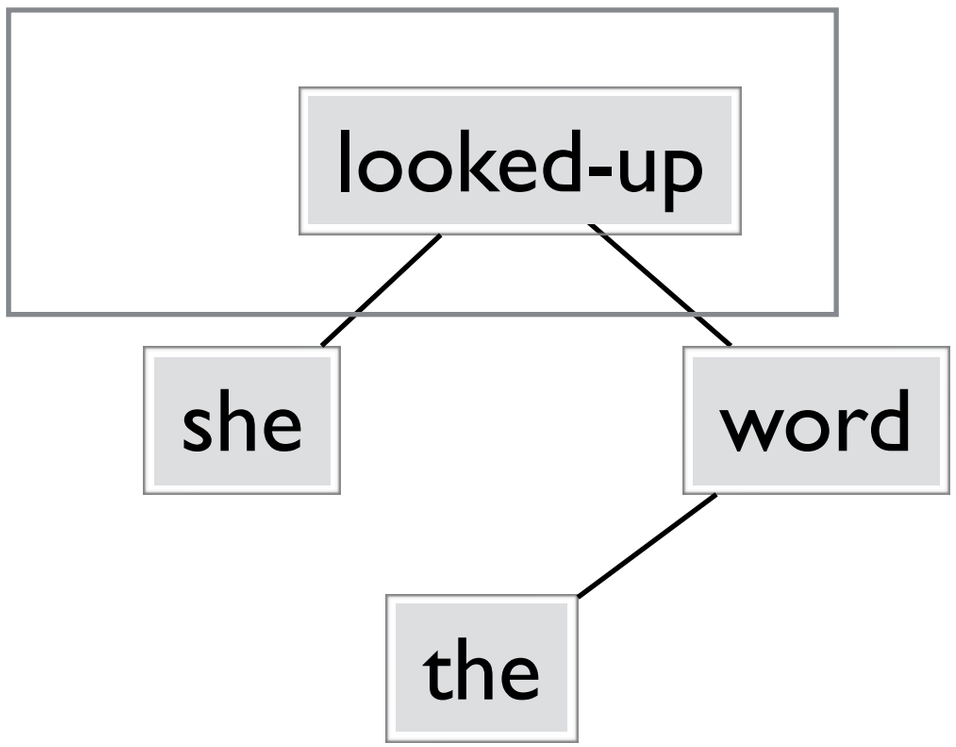

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Parsing Example 2

she	looked	the	word	up

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Parsing Example 2

she

looked | the | word | up

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Parsing Example 2

she looked

the word up

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Parsing Example 2

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Parsing Example 2

she | looked | the | word

up

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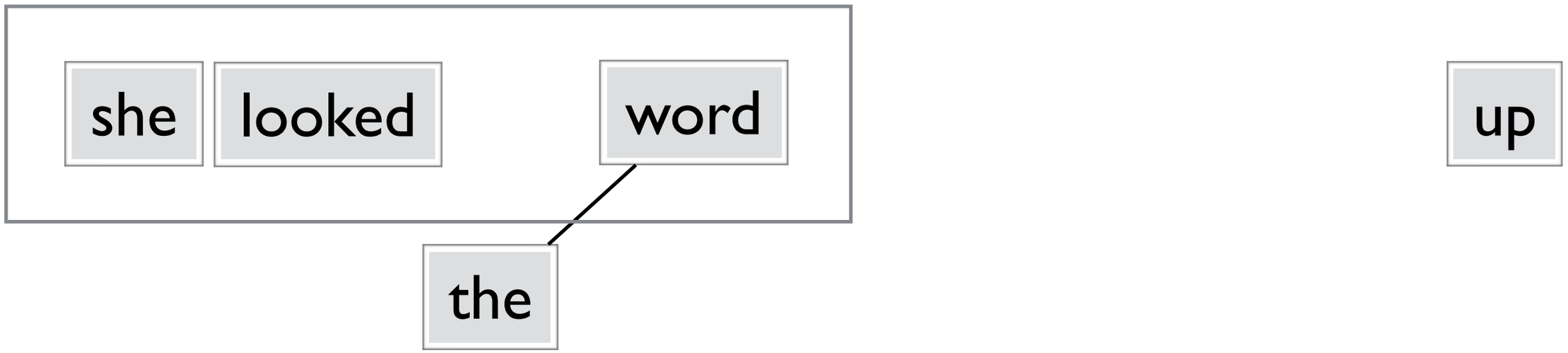
Parsing Example 2



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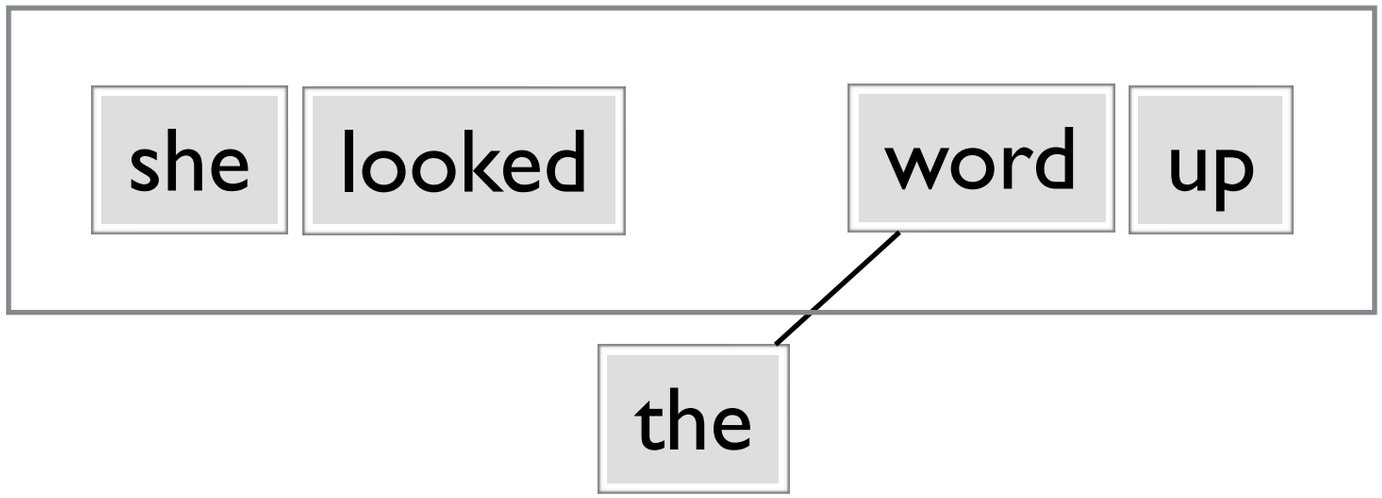
Parsing Example 2



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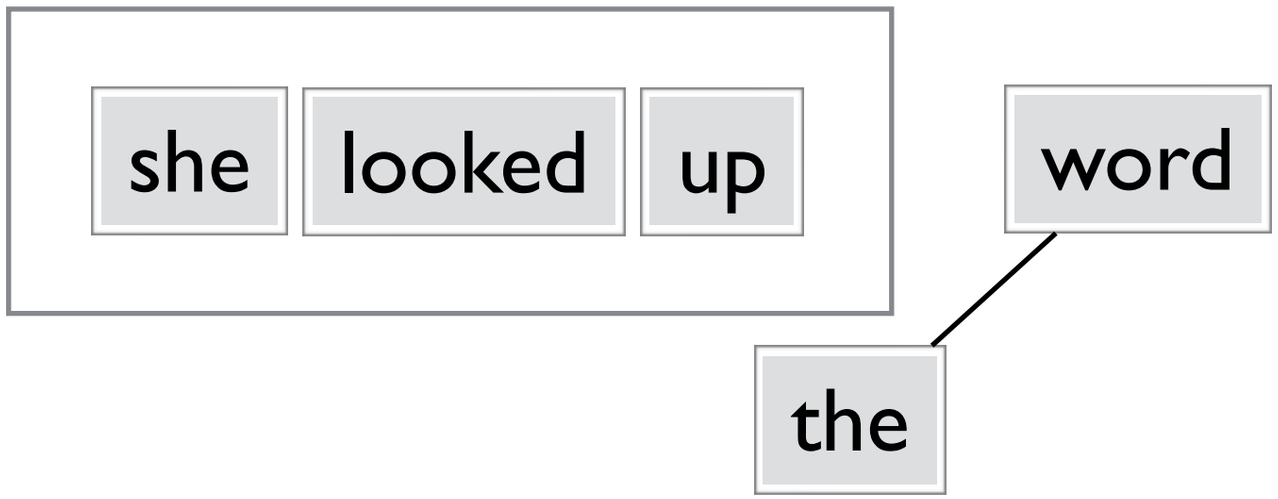

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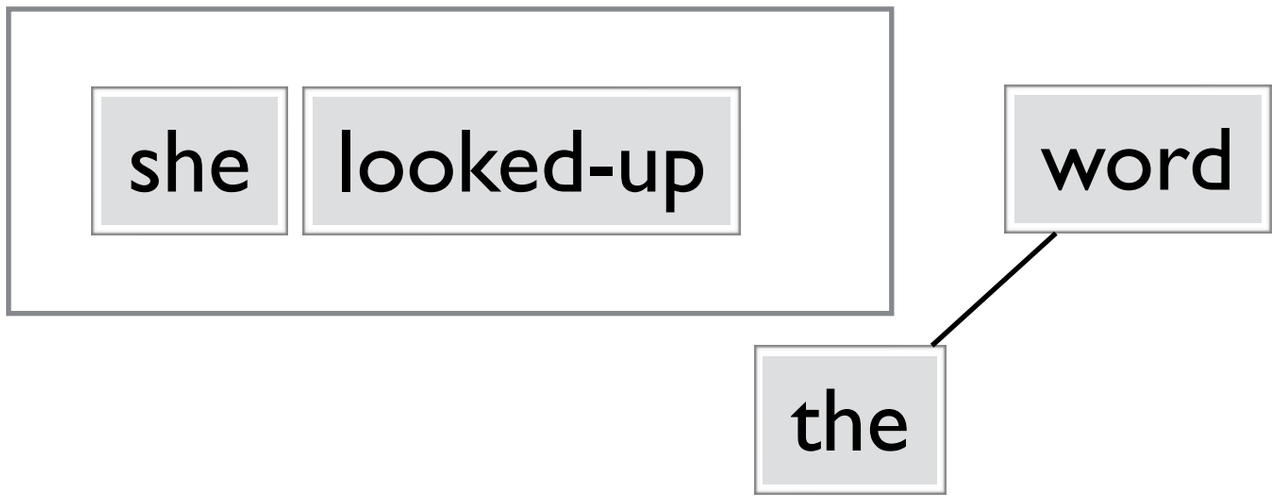

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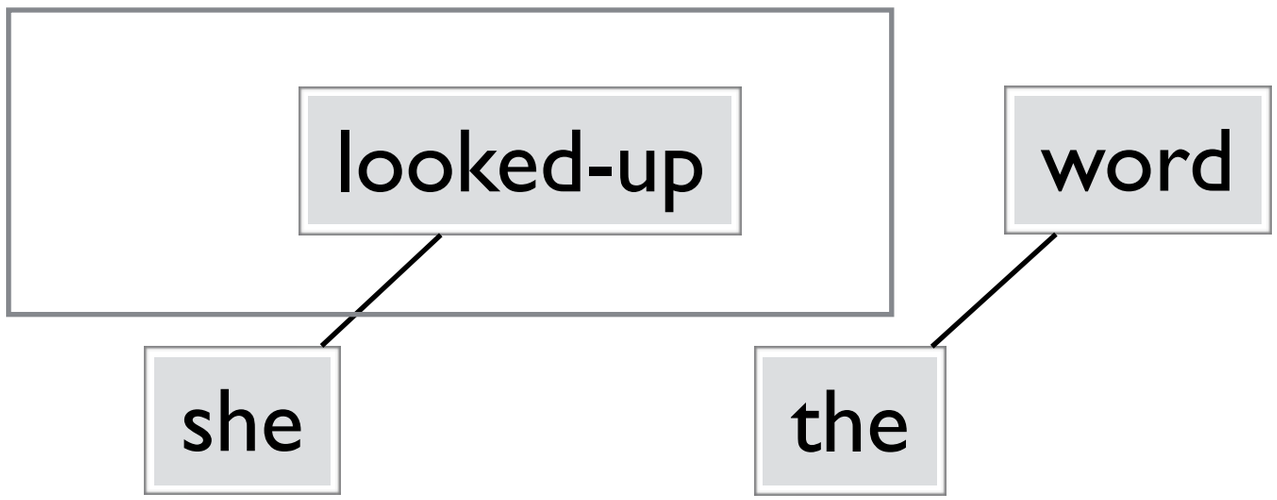

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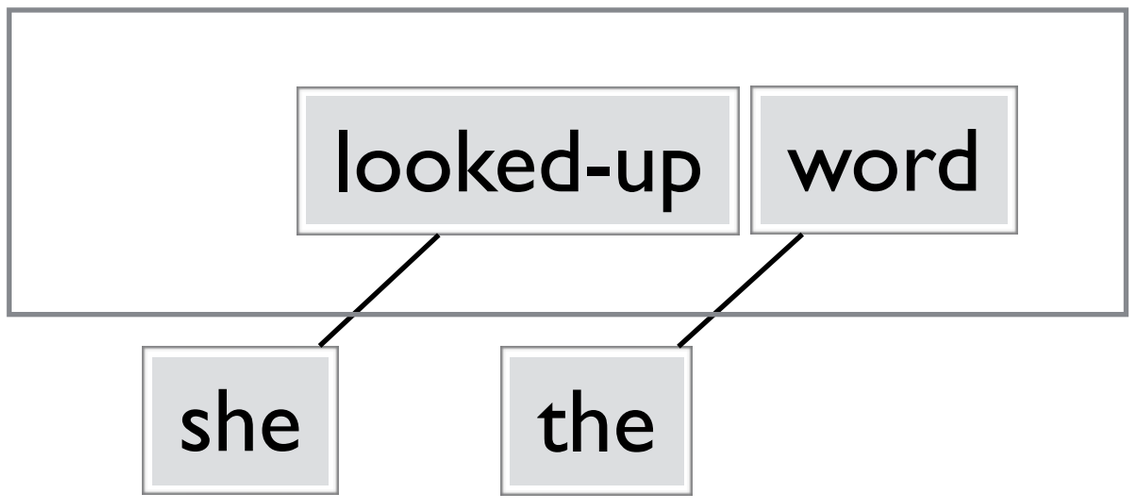

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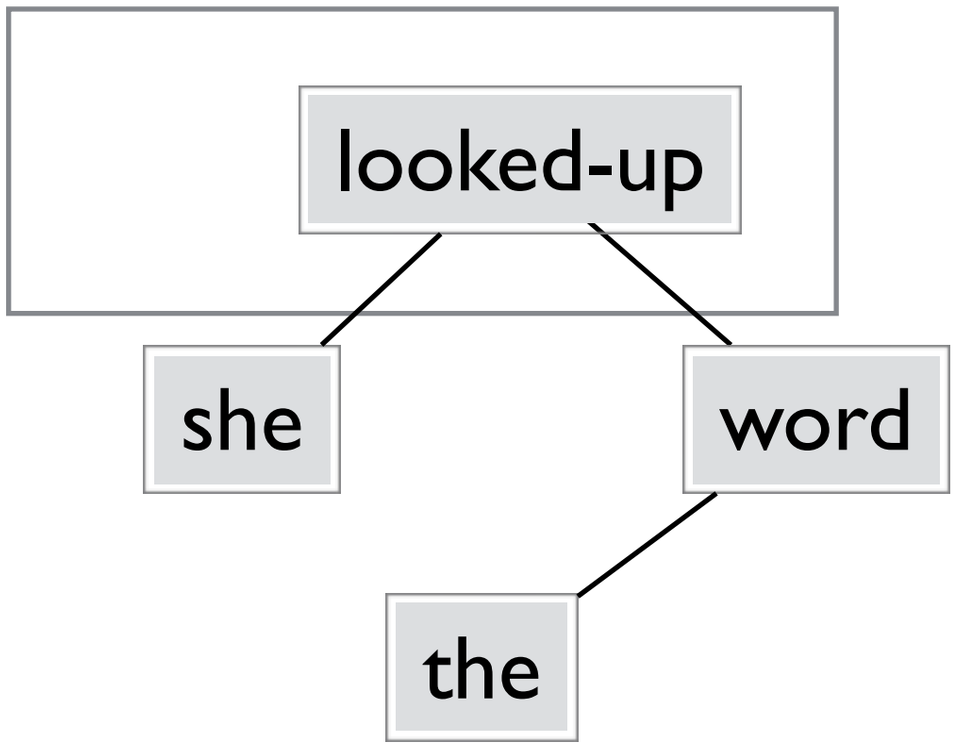

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Why stop here?

- Keep tokens and nodes ontologically distinct
  - Tokens live in the buffer and can be consumed by transitions
  - Nodes live on the stack and can be created by transitions
- Complete flexibility
  - Consume 1 token (*du*), create *m* nodes (*de le*)
  - Consume *m* tokens (*à cause de*), create 1 node (*à-cause-de*)
  - Consume 0 tokens, create 1 node (ellipsis?)
  - Consume 1 token, create 0 nodes (punctuation?)

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Discussion

- Open issues
  - How to integrate morphology?
  - How to do feature extraction?
  - How to make use of lexical resources?
- MWEs do not form a homogeneous class
  - Preprocessing for unambiguous fixed expressions?
  - Chunking for semi-flexible (possibly discontiguous) expressions?
  - Full dependency parsing for compositional expressions?