ClausIE: Clause-Based Open Information Extraction

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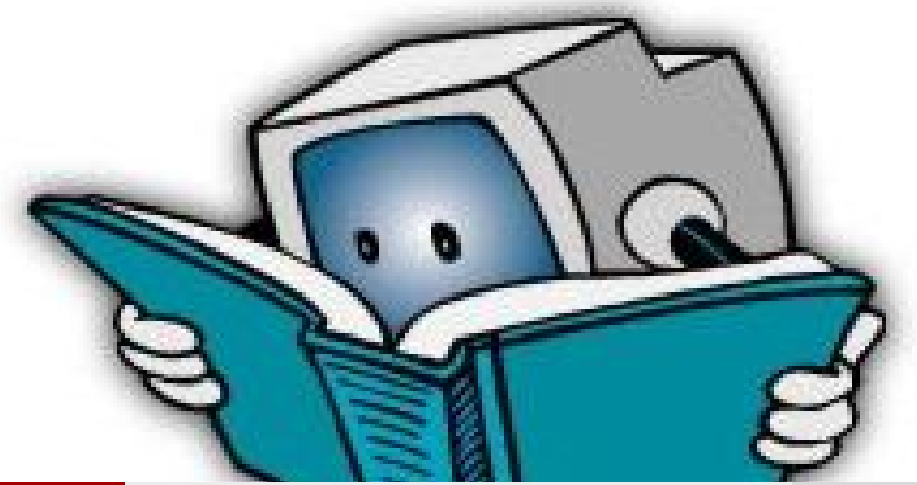

Open Information Extraction: From sentences to propositions

GOAL: Extract information from natural text

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(Bell,	is based in,	Los Angeles)
(Bell,	makes,	electronic products)
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Most OIE extractors

- Propositions expressed as triples $(arg_1, relation, arg_2)$
- Verb based relation
- Arguments restricted to noun phrases

Open Information Extraction: challenges and applications

Challenges/Requirements

- Domain independent
- Unbounded set of relations
- No filtering of information
- Structured output
- Scalable

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Applications

- Structured search
- Automatic ontology construction
- Question answering
- Semantic role labeling, discourse parsing, ... ?

Outline

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Information and Representation: a two-step approach

Information

- What information is expressed?
- How much to retain?
- How to identify it? (e.g. non-verb mediated propositions‘)
  - ⋆ Messi, a golden ball winner, plays in Barcelona

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- What is the form of the relation?
  - ⋆ Messi plays in Barcelona $\rightarrow$ *plays* or *plays in*
- Triples or n-ary propositions?
  - ⋆ *(Messi, plays football in, Barcelona)* or *(Messi, plays, football, in Barcelona)*
- What should be the scope of the arguments?
  - ⋆ Gandhi was vegetarian

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We aim to separate these two phases

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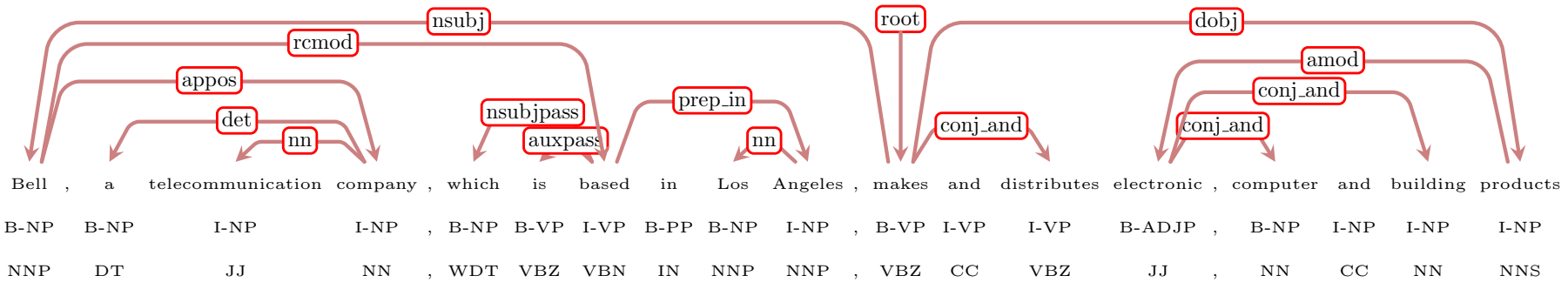
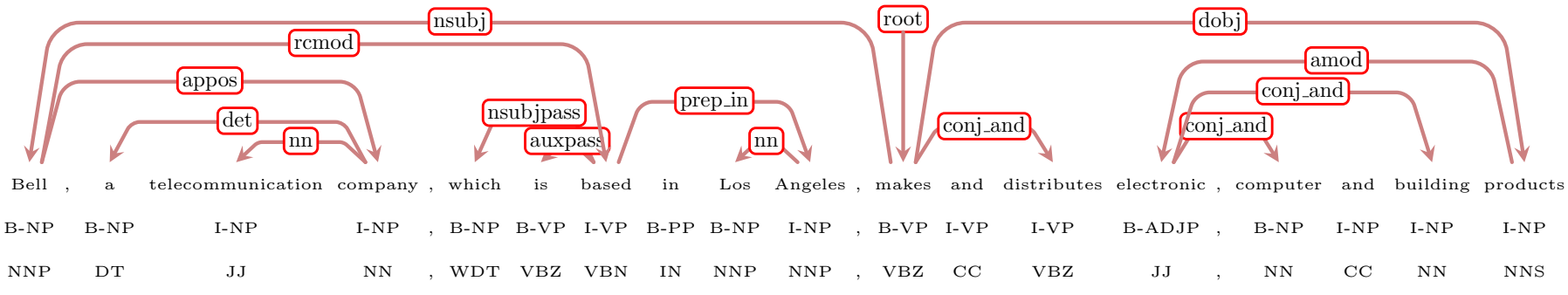
Open Information Extractors and Language Technology



Open Information Extractors and Language Technology



Chunks/POS

- TextRunner
- WOE^{pos}
- Reverb

Dependency Parser

- Wanderlust
- WOE^{parse}
- KrakeN
- OLLIE

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  - ⋆ Paul eats a chocolate bar

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- Clauses can have optional adverbials
  - ⋆ He will take the exam in May
- A minimal clause is a clause without its optional adverbials
  - ⋆ He will take the exam

The seven clauses

1. SV_i → Albert Einstein died.

S: Subject, **V:** Verb, **A:** Adverbial, **C:** Complement, **O_i:** Indirect Object, **O:** Direct Object

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3. $SV_c\ C$ → Albert Einstein is smart.

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3. $SV_c\ C$ → Albert Einstein is smart.
4. $SV_{mt}\ O$ → Albert Einstein has won the Nobel Prize.
5. $SV_{dt}\ O_i\ O_d$ → RSAS gave Albert Einstein the Nobel Prize.
6. $SV_{ct}\ O\ A$ → The doorman showed Albert Einstein to his office.
7. $SV_{ct}\ O\ C$ → Albert Einstein declared the meeting open.

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S: Subject, **V**

By identifying each minimal clause in a sentence we can identify the essential information

ect

The seven clauses: optional adverbials

Pattern	Clause Type	Example	Derived clauses
		Some extended patterns	
$SV_i AA$	SV	AE died in Princeton in 1955.	(AE, died) (AE, died, in Princeton) (AE, died, in 1955) (AE, died, in Princeton, in 1955)

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SV_iAA	SV	AE died in Princeton in 1955.	(AE, died) (AE, died, in Princeton) (AE, died, in 1955) (AE, died, in Princeton, in 1955)
SV_eAA	SVA	AE remained in Princeton until his death.	(AE, remained, in Princeton) (AE, remained, in Princeton, until his death)

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SV_iAA	SV	AE died in Princeton in 1955.	(AE, died) (AE, died, in Princeton) (AE, died, in 1955) (AE, died, in Princeton, in 1955)
SV_eAA	SVA	AE remained in Princeton until his death.	(AE, remained, in Princeton) (AE, remained, in Princeton, until his death)
SV_cCA	SVC	AE is a scientist of the 20th century.	(AE, is, a scientist) (AE, is, a scientist, of the 20th century)
$SV_{mt}OA$	SVO	AE has won the Nobel Prize in 1921.	(AE, has won, the Nobel Prize) (AE, has won, the Nobel Prize, in 1921)
$ASV_{mt}O$	SVO	In 1921, AE has won the Nobel Prize.	(AE, has won, the Nobel Prize) (AE, has won, the Nobel Prize, in 1921)

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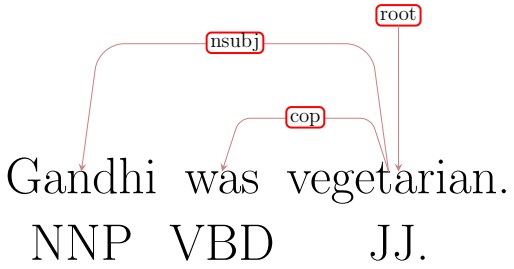
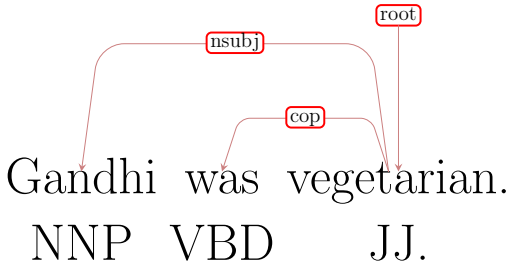
From clauses to clause types (I)



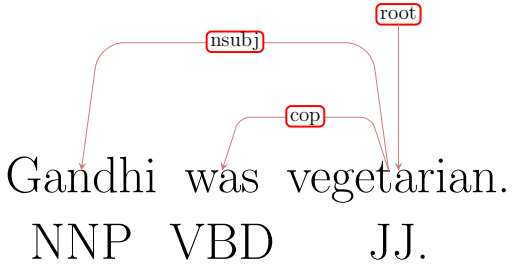
DP

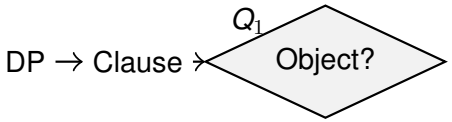
From clauses to clause types (I)



DP → Clause

From clauses to clause types (I)





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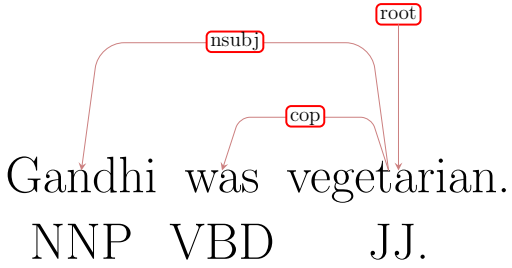

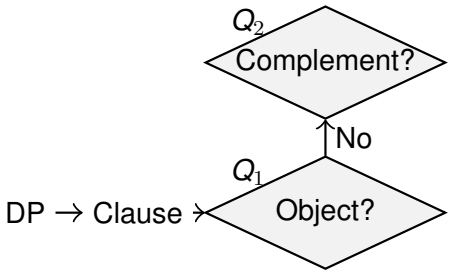

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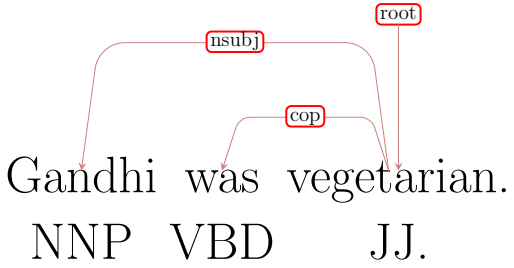

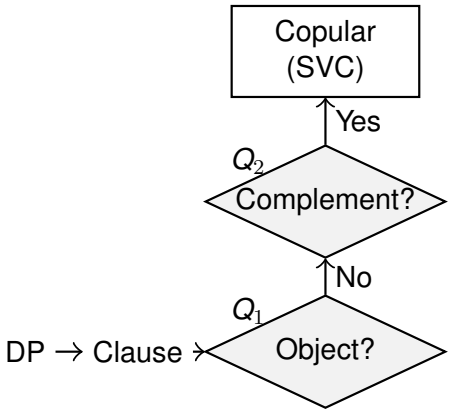

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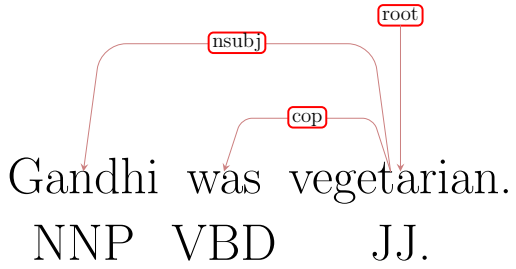
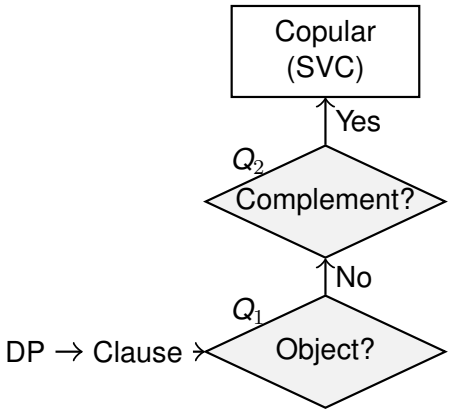


→ (**S:** *Gandhi*, **V:** *was*, **C:** *vegetarian*)



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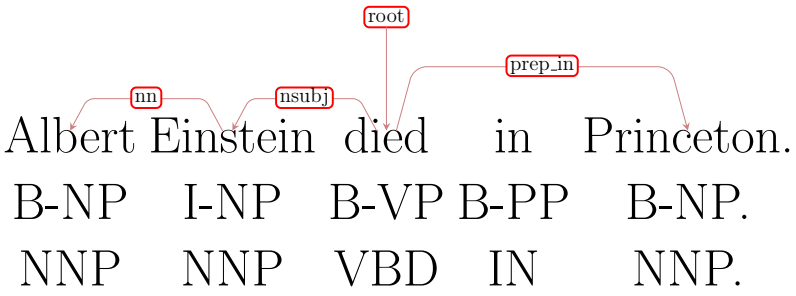

DP

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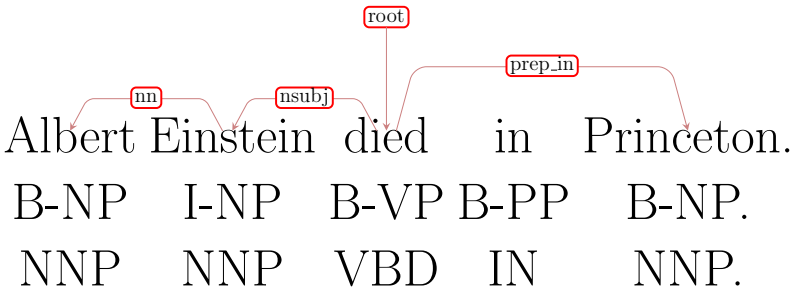

DP → Clause

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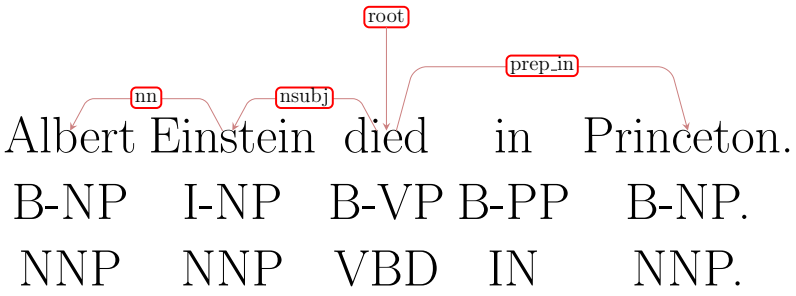

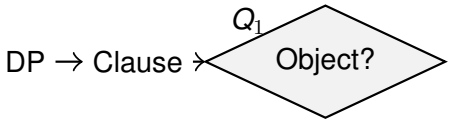

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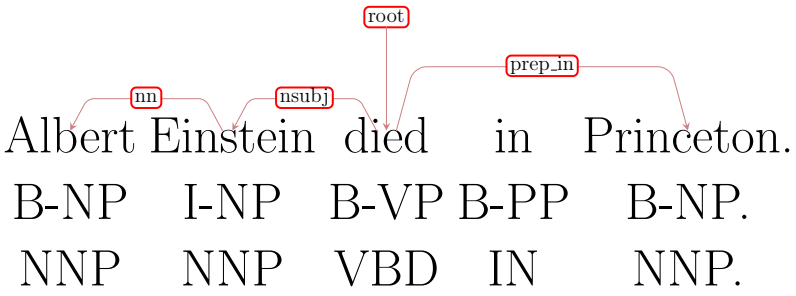

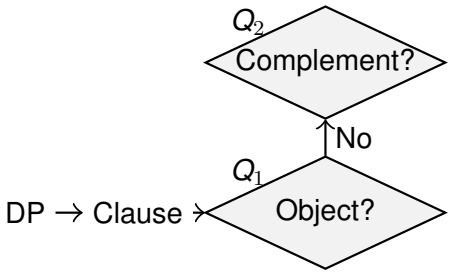

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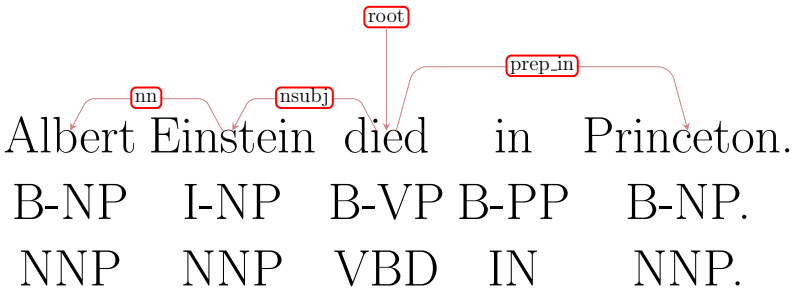

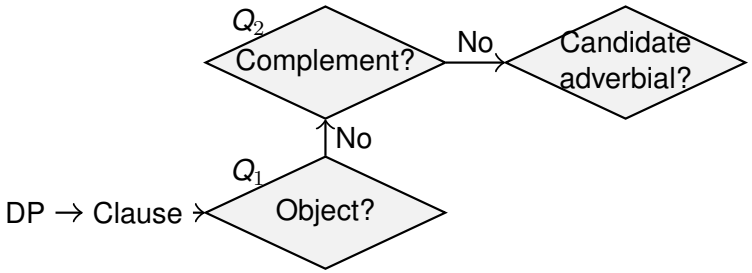

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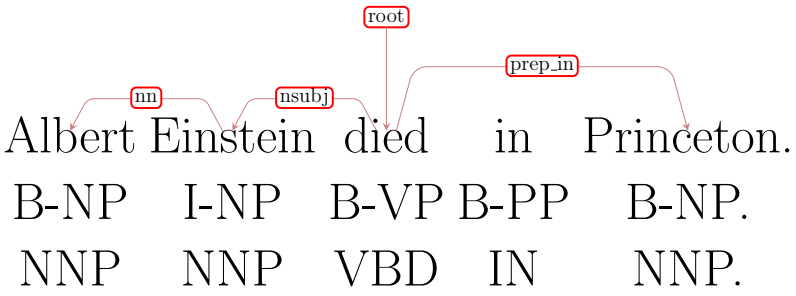

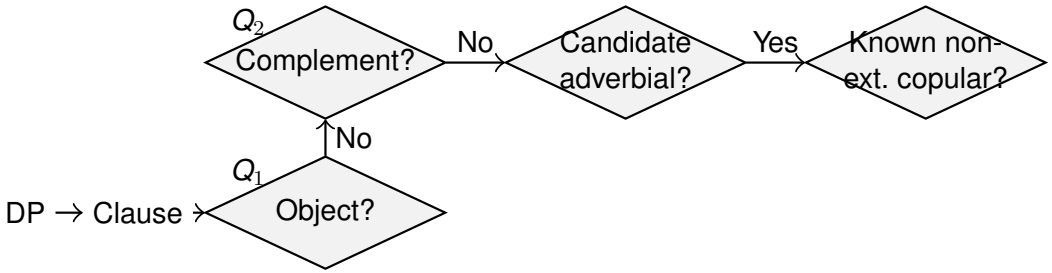

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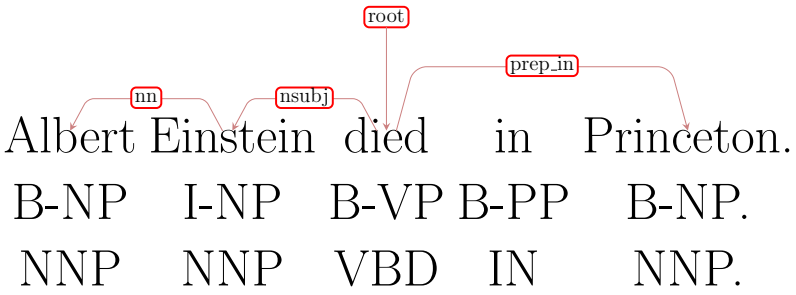

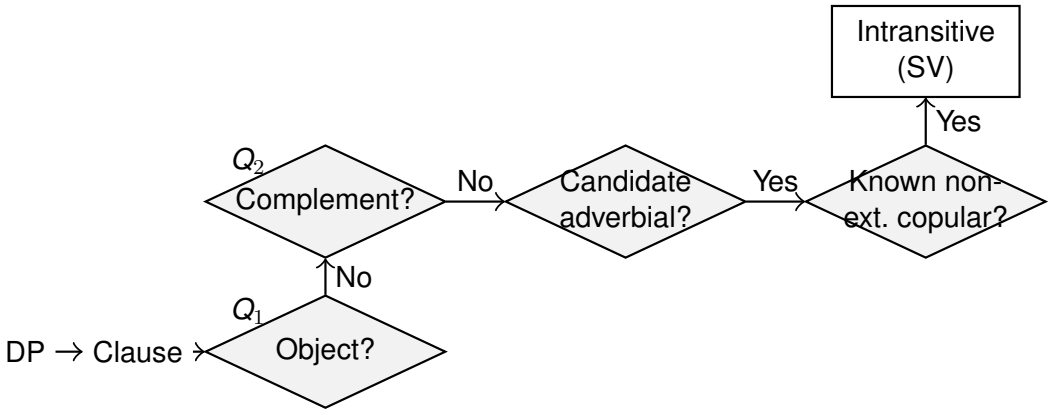

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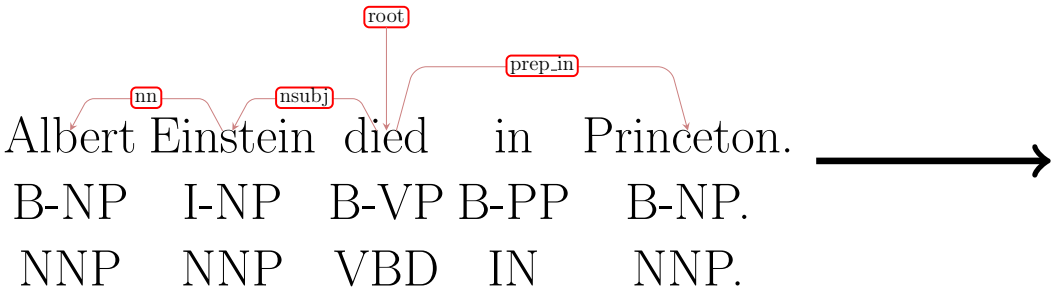

*(**S:** AE, **V:** died,)*
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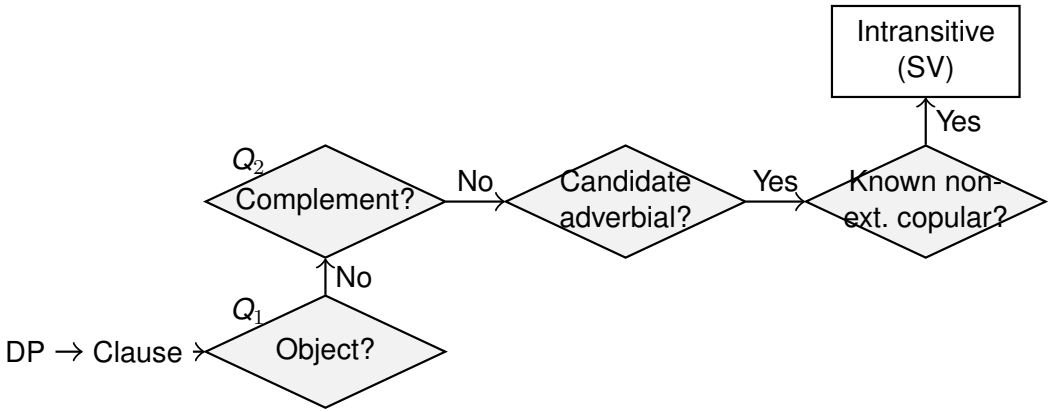

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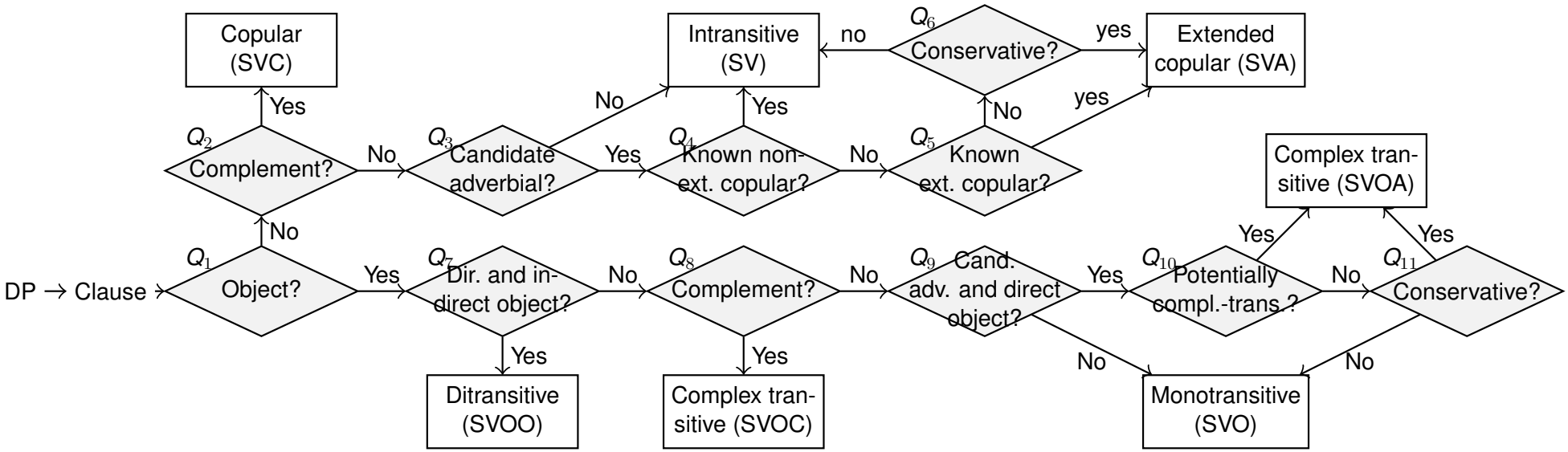

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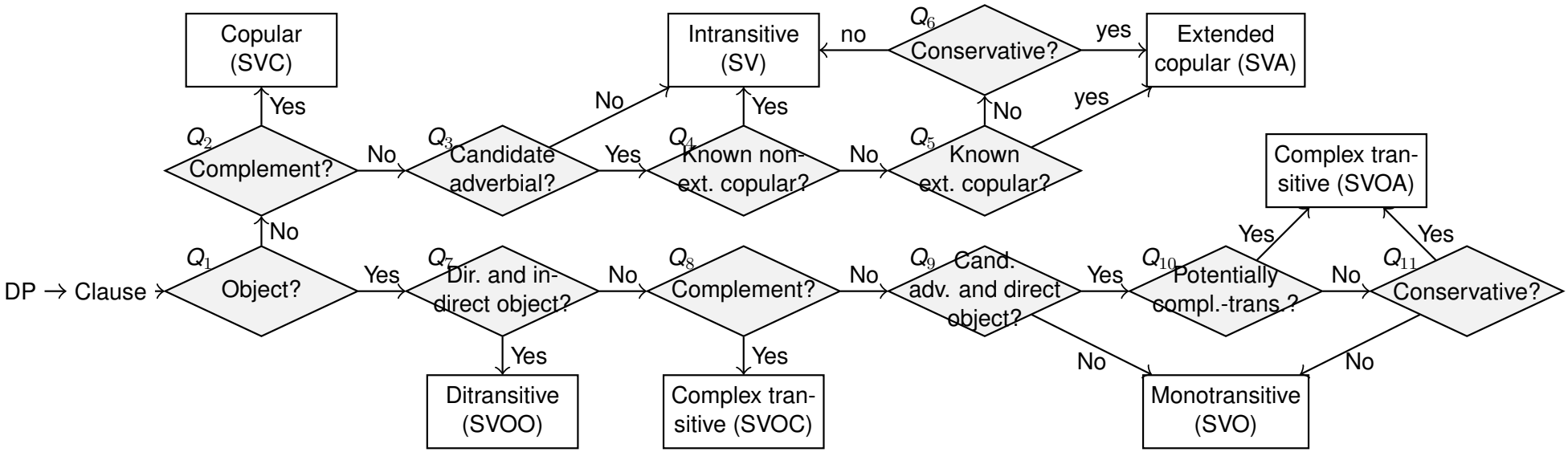

We first identify the information and then generate the proposition.

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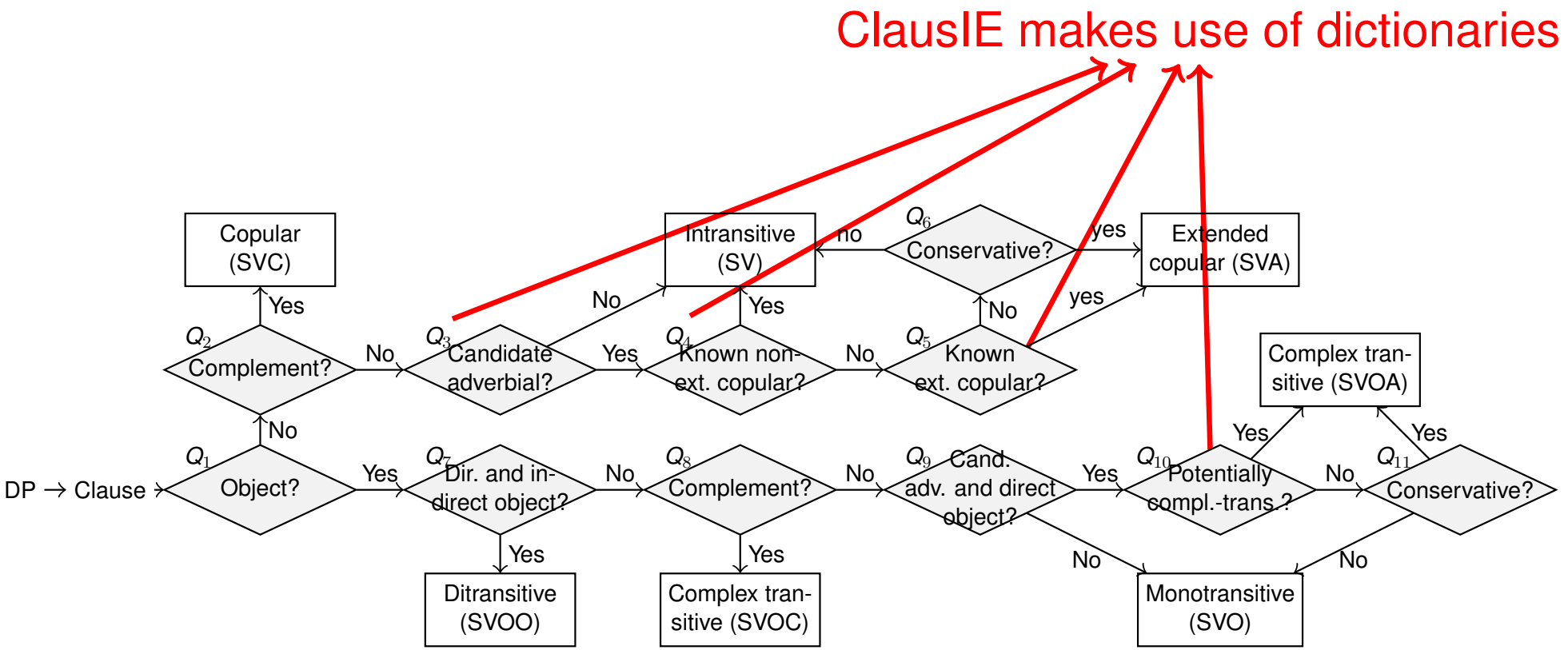

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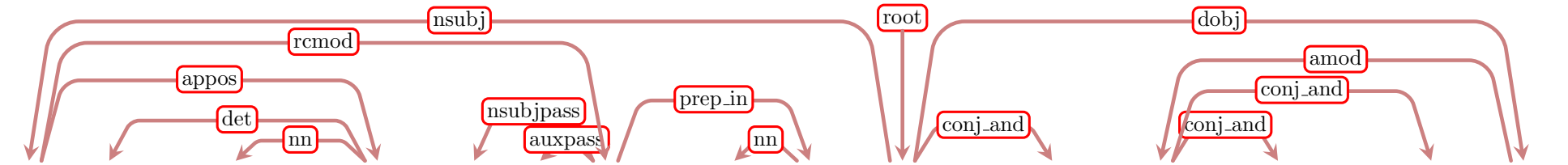
Example



Bell	,	a	telecommunication	company	,	which	is	based	in	Los	Angeles	,	makes	and	distributes	electronic	,	computer	and	building	products
B-NP		B-NP	I-NP	I-NP	,	B-NP	B-VP	I-VP	B-PP	B-NP	I-NP	,	B-VP	I-VP	I-VP	B-ADJP	,	B-NP	I-NP	I-NP	I-NP
NNP		DT	JJ	NN	,	WDT	VBZ	VBN	IN	NNP	NNP	,	VBZ	CC	VBZ	JJ	,	NN	CC	NN	NNS

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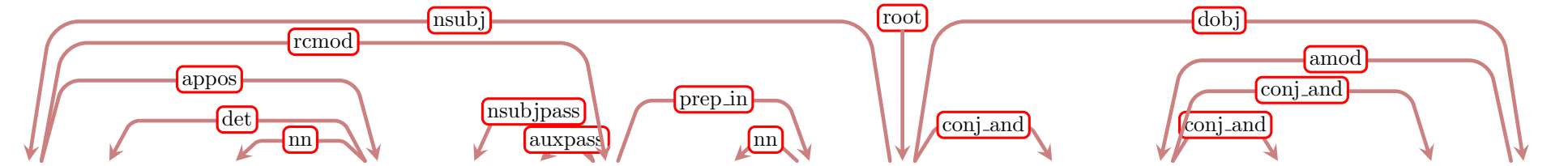
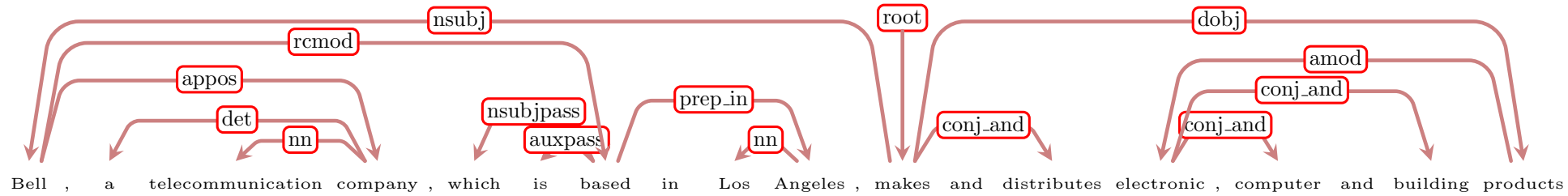


Bell, a telecommunication company, which is based in Los Angeles , makes and distributes electronic, computer and building products.

Example



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Reverb $\rightarrow$ (*a telecommunication company, is based in, Los Angeles*)

Ollie $\rightarrow$ (*Bell, distributes, electronic , computer and building products*)

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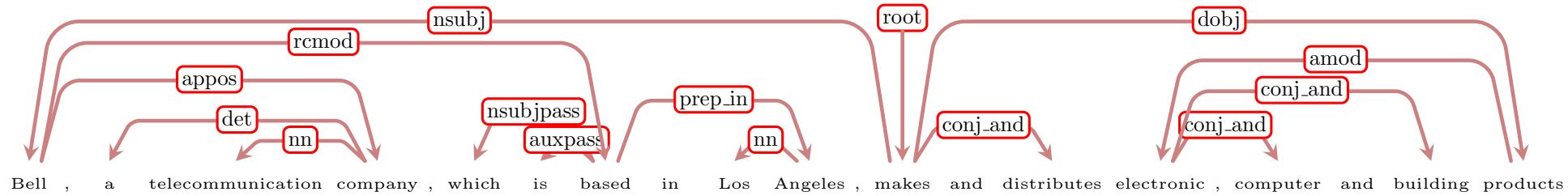

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ClausIE →
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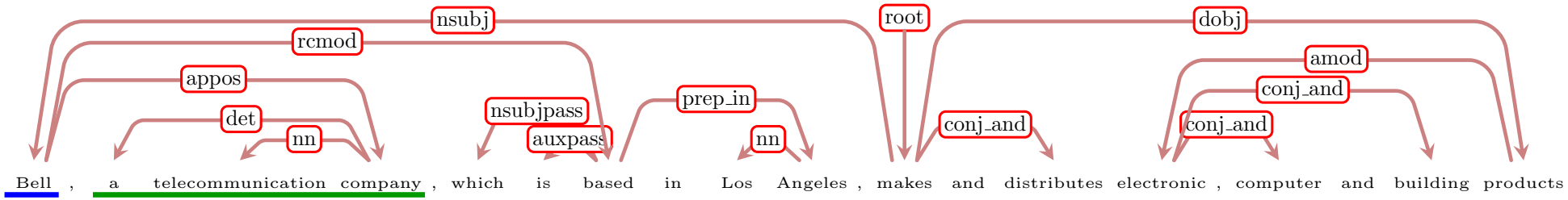

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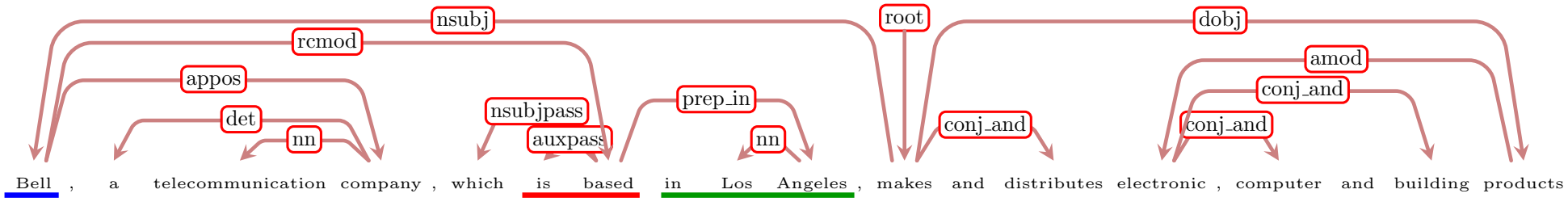

Bell, a telecommunication company, which is based in Los Angeles , makes and distributes electronic, computer and building products.

Reverb → (*a telecommunication company,* *is based in,* *Los Angeles*)

Ollie → (*Bell,* *distributes,* *electronic , computer and building products*)

ClausIE →
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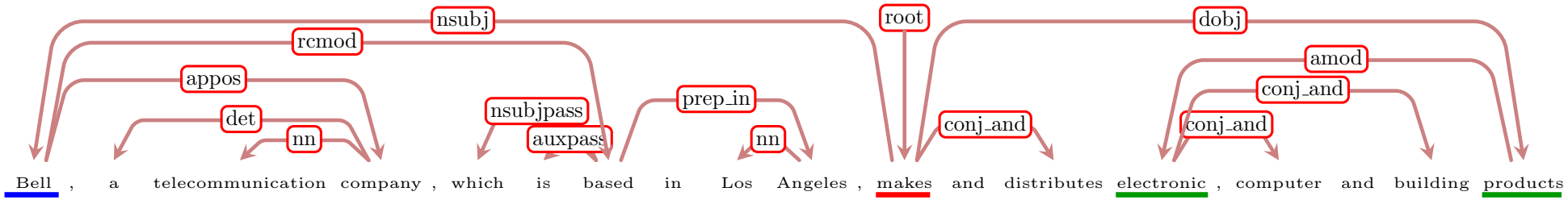

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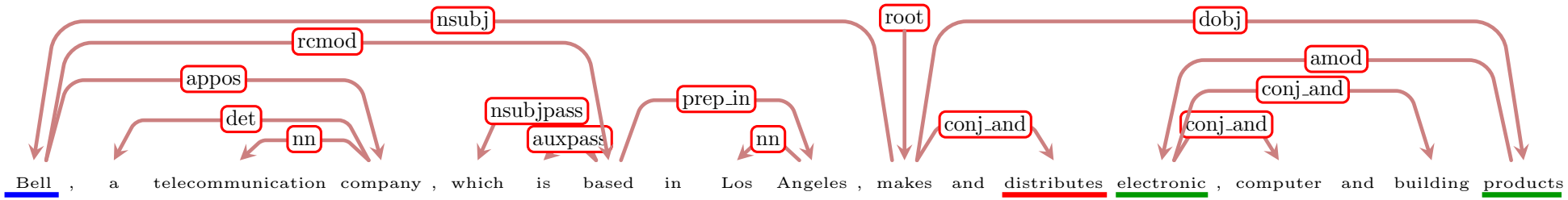

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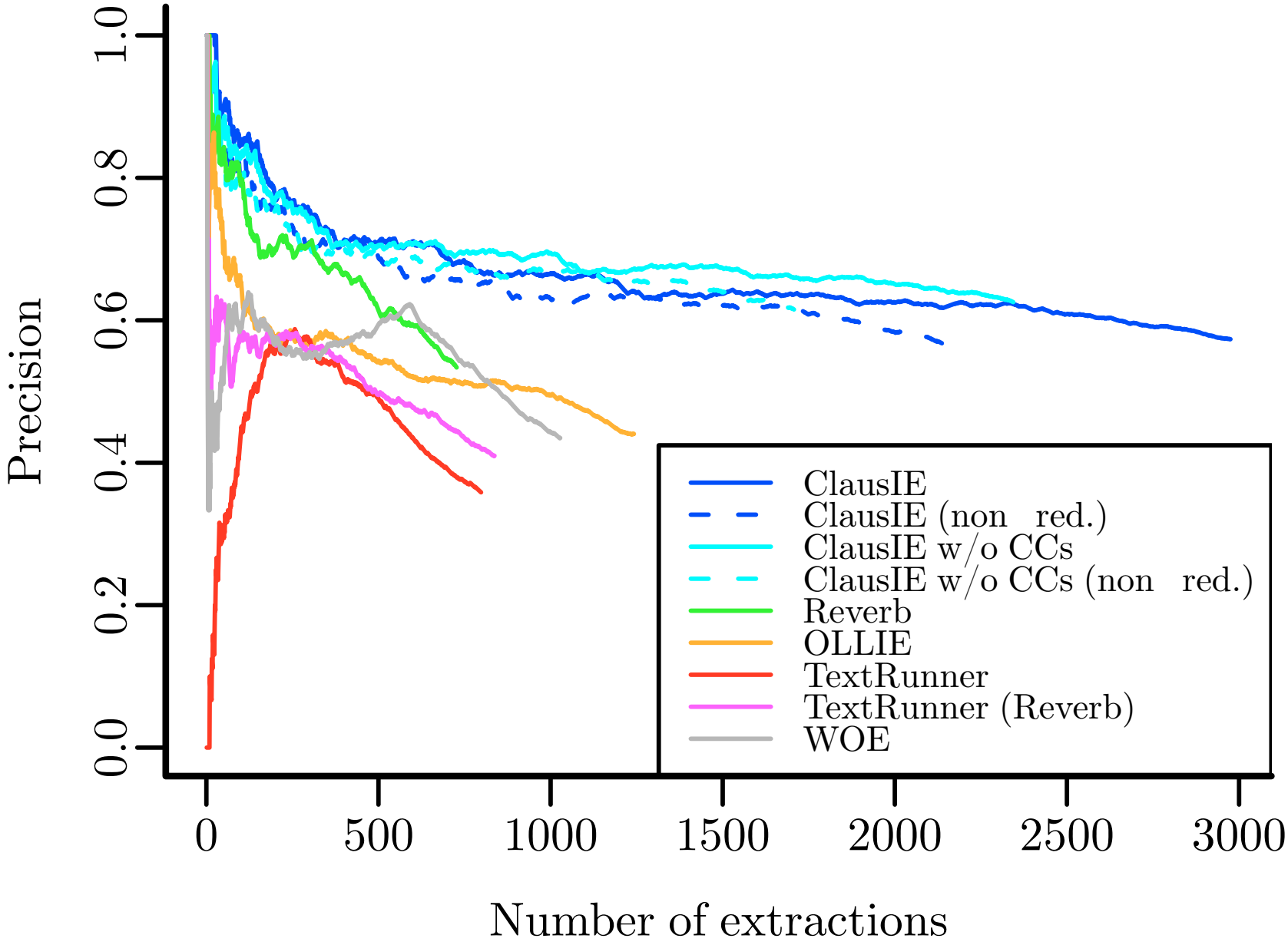
- Optional arguments can be used to generate new propositions
  - ⋆ *(Paul, takes, a shower, in the morning)* or *(Paul, takes, a shower)*

Outline

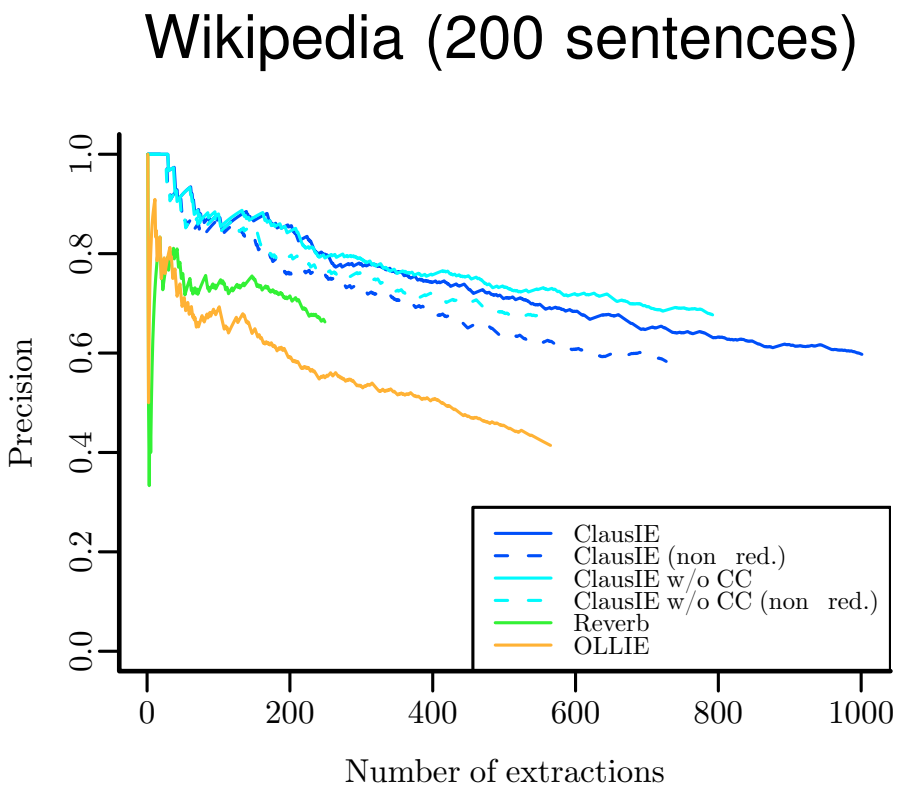
Evaluation

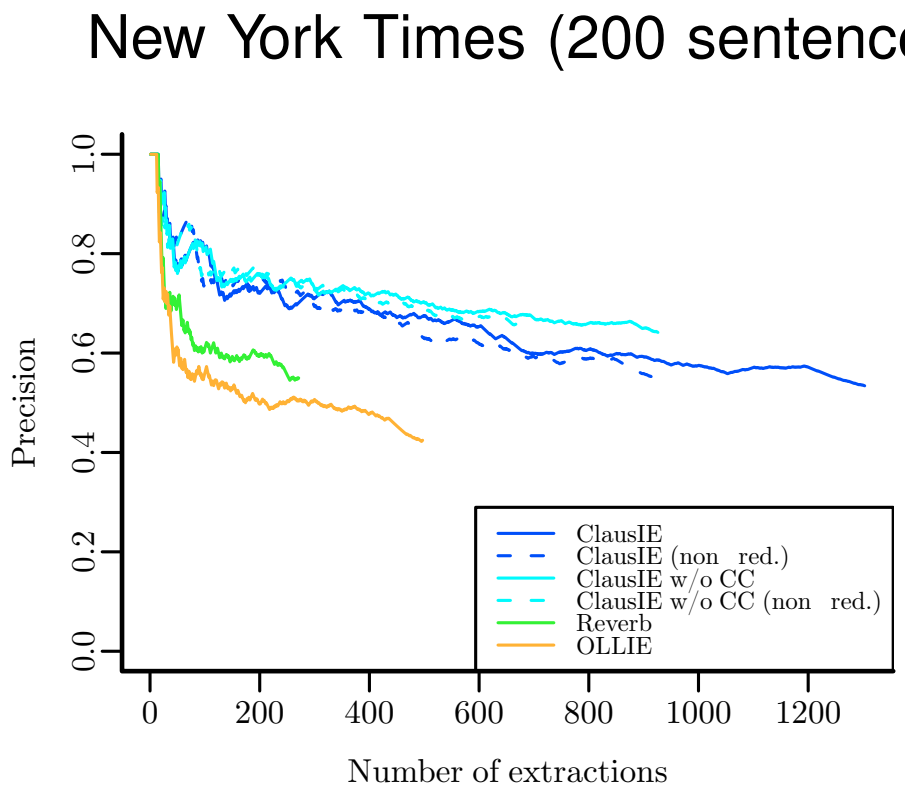
- 3 datasets
  - Reverb: Web, very noisy (500 sentences)
  - New York Times: Complex, written by experts (200 sentences)
  - Wikipedia: Simple, written by non-experts (200 sentences)
- 2 labelers, pessimistic approach.
- Agreement 57%-68%.
- High precision, high recall.

Results I: Reverb Sentences



Results II: Wikipedia and New York Times





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- Post processing of arguments
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Thank You!