

Computing the scope of Negation



Master Seminar in Language Technology, spring 2011

Computing the scope of Negation

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With thanks to Lilja Øvrelid and Jonathon Read

Computing the scope of Negation

Overview

:: Motivation

:: Corpora

:: System

:: Motivation

“[...] negation is what makes us human, imbuing us with the capacity to deny, to contradict, to misrepresent, to lie, and to convey irony.”

[Horn, 2010]

An important NLP subtask

Textual entailment

Information extraction

Dialogue systems

Sentiment analysis

Scope

(1) Mario is not tall but he is happy.

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- (2) Mario is not short and sad.

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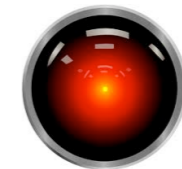
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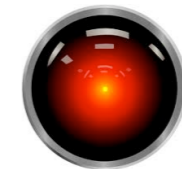
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- (5) Mario doesn't kill Bowser **because they are friends**.



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There is more to negation than the adverb *not* !

Scope

VERBS Journalists were **denied** access to the site.

Scope

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NOUNS **Lack** of founding brought the project to a halt

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ADJECTIVES Wings are **absent** in several species of crane flies

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PREPOSITIONS **Without** a doubt.

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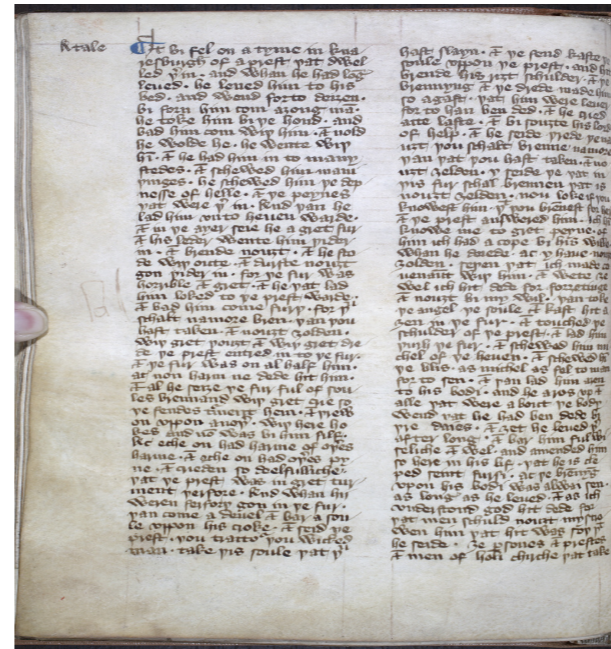
ADJECTIVES Wings are **absent** in several species of crane flies

PREPOSITIONS **Without** a doubt.

DETERMINERS All work and **no** play makes Jack a dull boy.

Computing the scope of Negation

:: Corpora



The Product Review Corpus

Facts

262 reviews from Google Product Review

2107 sentences

616 contain negation

732 scopes

The Product Review Corpus

Annotations

:: Negation cues not in scope

The Product Review Corpus

Annotations

:: Negation cues not in scope

:: Negation cues are **not** annotated

The Product Review Corpus

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- :: Negation cues not in scope
- :: Negation cues are **not** annotated
- :: Scopes never overlap

The Product Review Corpus

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- :: Scopes are continuous

The Product Review Corpus

Annotations

- :: Negation cues not in scope
- :: Negation cues are **not** annotated
- :: Scopes never overlap
- :: Scopes are continuous
- :: No morphologic negation cues

The Product Review Corpus

Annotations

- Adverbial cues do not negate “their” verb and its subject:

“They are not.”

“I couldn't <negation_span> put the book down </negation_span>”

The Product Review Corpus

Annotations

- Adverbial cues do not negate “their” verb and its subject:

“They are not.”

“I couldn't <negation_span> put the book down </negation_span>”

- Scopes rarely occur to the left of a cue:

“I like the fairytale elements, but <negation_span> subtle </negation_span>
it ain't.”

The Product Review Corpus

Domain

- User generated content:

“The music sounds kinda like the ones played in the first Fire Emblem for the GBA but it cool nonetheless.”

The Product Review Corpus

Domain

- User generated content:

“The music sounds kinda like the ones played in the first Fire Emblem for the GBA but it cool nonetheless.”

- Suitable for sentiment analysis:

“Alright, the **best** songs are Ain't <negation_span> My B**** </negation_span> , Until it Sleeps, Bleeding Me, and Outlaw Torn. The **worst** songs are Cure, and Poor Twisted Me. The other songs are **mediocre**, **alright**, or **pretty good**.”

The Product Review Corpus

Ouch!

- Annotation inconsistencies:

“Unfortunately this game will not <negation_span> get played </negation_span> as my children aren't Metallica fans.”

“The actress is perfect and the choices of how to cut the parts that confuse the strong narrative for a film are well met without cutting the hint of what happens, though does cut much of the motivation already hinted at more fully in this first book.”

The Product Review Corpus

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- UGC is hard to parse and tag!

The CD-SCO corpus

Facts

2 stories by Conan Doyle

3644 sentences

986 contain negation

893 scopes

The CD-SCO corpus

Annotation

:: Negation cues not in scope

The CD-SCO corpus

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:: Negation cues not in scope

:: Negation cues are annotated

The CD-SCO corpus

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The CD-SCO corpus

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The CD-SCO corpus

Annotation

- :: Negation cues not in scope
- :: Negation cues are annotated
- :: Scopes overlap
- :: Discontinuous scopes
- :: Morphologic and multi-word cues
- :: Lemmatized, POS-tagged and parsed
- :: Negated *events* within the scope

The CD-SCO corpus

Facts

Pseudo-CoNLL format:

262	HoundOfTheBaskervilles_ch1	12	0	Since	since	IN	(S(SBAR*	_	_	_	_	_	_
263	HoundOfTheBaskervilles_ch1	12	1	we	we	PRP	(S*_	we	_	_	we	_	_
264	HoundOfTheBaskervilles_ch1	12	2	have	have	VBP	(VP(VP*	_	have	_	_	_	_
265	HoundOfTheBaskervilles_ch1	12	3	been	be	VBN	(VP*	_	been	_	_	_	_
266	HoundOfTheBaskervilles_ch1	12	4	so	so	RB	(ADJP*	_	so	_	_	_	_
267	HoundOfTheBaskervilles_ch1	12	5	unfortunate	unfortunate	JJ	*ADJP)	un	fortunate	fortunate	_	_	_
268	HoundOfTheBaskervilles_ch1	12	6	as	as	IN	(SBAR*	_	as	_	_	_	_
269	HoundOfTheBaskervilles_ch1	12	7	to	to	TO	(VP*	_	to	_	_	_	_
270	HoundOfTheBaskervilles_ch1	12	8	miss	miss	VB	(VP*	_	miss	_	_	_	_
271	HoundOfTheBaskervilles_ch1	12	9	him	him	PRP	*VP)VP)SBAR)VP)VP)	_	him	_	_	_	_
272	HoundOfTheBaskervilles_ch1	12	10	and	and	CC	*	_	_	_	_	_	_
273	HoundOfTheBaskervilles_ch1	12	11	have	have	VBP	(VP*	_	_	_	have	have	_
274	HoundOfTheBaskervilles_ch1	12	12	no	no	DT	(NP(NPB*	_	_	_	no	_	_
275	HoundOfTheBaskervilles_ch1	12	13	notion	notion	NN	*NPB)	_	_	_	notion	_	_
276	HoundOfTheBaskervilles_ch1	12	14	of	of	IN	(PP*	_	_	_	of	_	_
277	HoundOfTheBaskervilles_ch1	12	15	his	his	PRP\$	(NPB*	_	_	_	his	_	_
278	HoundOfTheBaskervilles_ch1	12	16	errand	errand	NN	*	_	_	_	errand	_	_
279	HoundOfTheBaskervilles_ch1	12	17	,	,	PUNC	*NPB)PP)NP)VP)VP)S)SBAR)	_	_	_	_	_	_
280	HoundOfTheBaskervilles_ch1	12	18	this	this	DT	(NPB*	_	_	_	_	_	_
281	HoundOfTheBaskervilles_ch1	12	19	accidental	accidental	JJ	*	_	_	_	_	_	_
282	HoundOfTheBaskervilles_ch1	12	20	souvenir	souvenir	NN	*NPB)	_	_	_	_	_	_
283	HoundOfTheBaskervilles_ch1	12	21	becomes	become	VBZ	(VP*	_	_	_	_	_	_
284	HoundOfTheBaskervilles_ch1	12	22	of	of	IN	(PP*	_	_	_	_	_	_
285	HoundOfTheBaskervilles_ch1	12	23	importance	importance	NN	(NPB*	_	_	_	_	_	_
286	HoundOfTheBaskervilles_ch1	12	24	.	.	PUNC	*NPB)PP)VP)S)	_	_	_	_	_	_

The CD-SCO corpus

Annotation

- Discontinuous scope

“[...] {those} <not> {infrequent occasions when he was up all night} [...]”

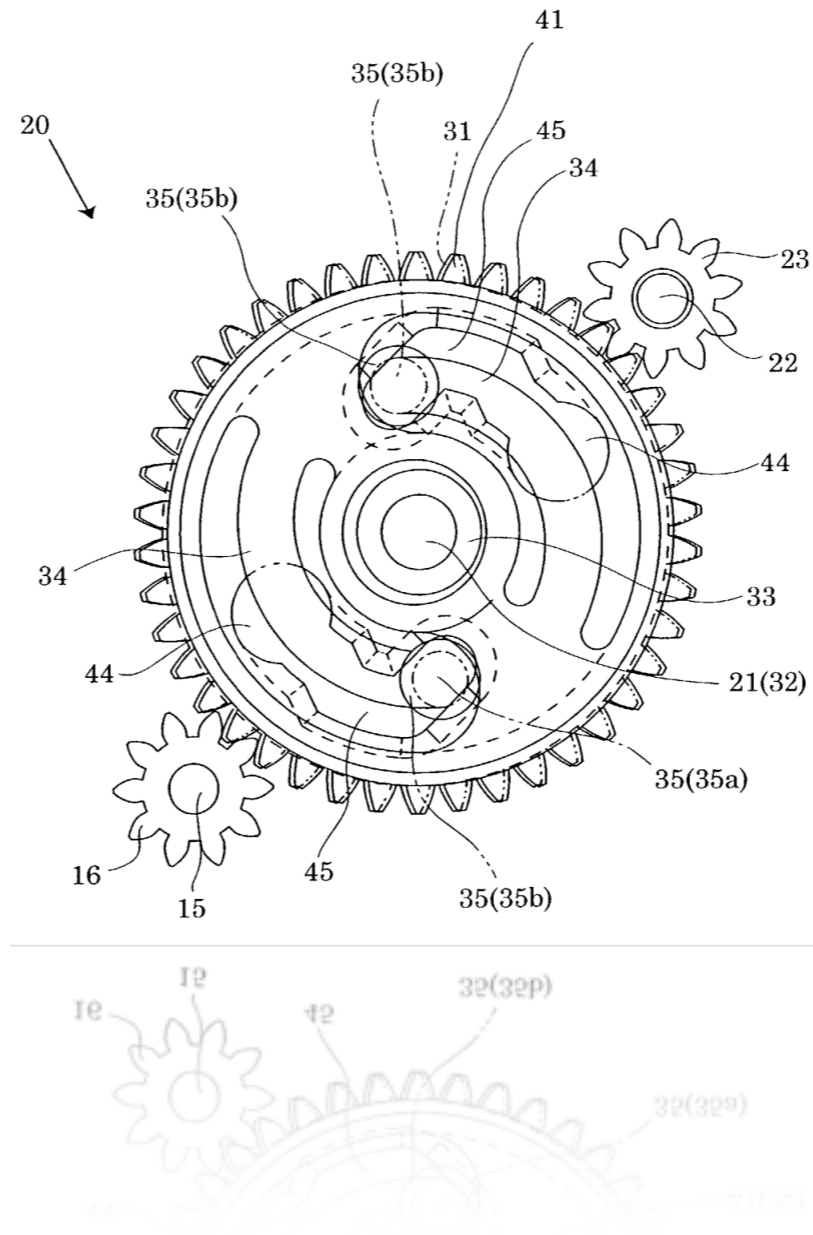
“[...] {he was} in the hospital and yet <not> {on the staff} [...]”

- Event

“{The dog's jaw}, as shown in the space between these marks,
{is} too broad in my opinion for a terrier and <not> {[broad]
enough for a mastiff}.”

Computing the scope of Negation

:: System



A system for NSR

In general

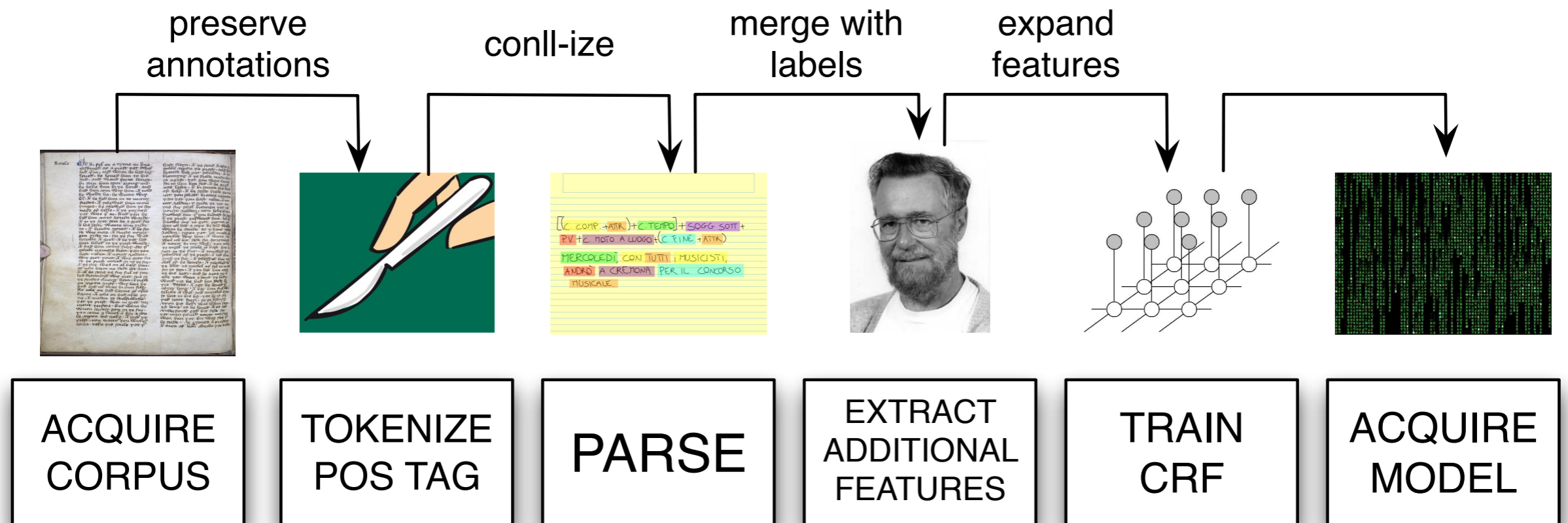
Inspired by Morante et al., 2009 and Councill et al., 2010: use supervised machine learning to assign a label to each token in a sentence.

The system was originally built around Product Review.

Focus: represent each sentence as a dependency graph and investigate the effect of features extracted via this representation.

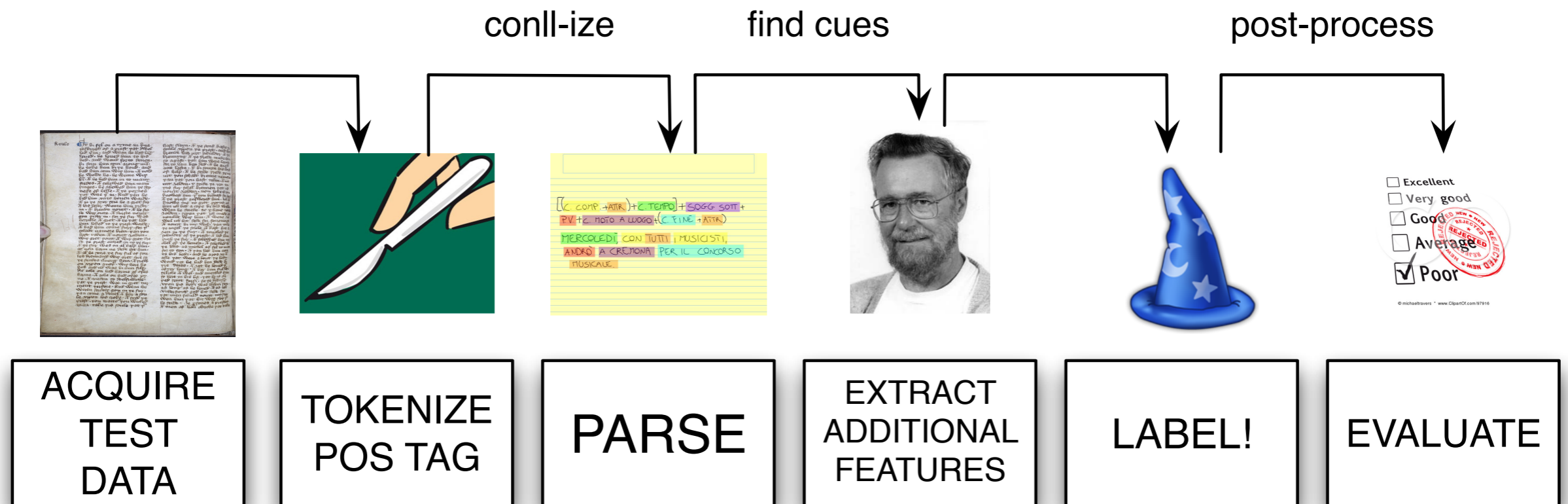
A system for NSR

Train



A system for NSR

Label



A system for NSR

A closer look



TOKENIZE
POS TAG

NLTK defaults work well and are a joy to use if your weapon of choice is Python.

In progress: use MULM, an HMM tagger by Lynum and Evensberger, to investigate the effect of different taggers in the pipeline.

A system for NSR

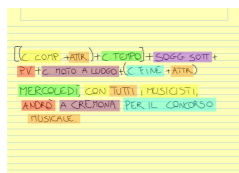
A closer look



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PARSE

MaltParser: robust, fast and pre-trained Dependency parser.

In progress: parse with a Constituency parser and use features from both.

A system for NSR

A closer look



EXTRACT
ADDITIONAL
FEATURES

Information from the parser used to represent each token as a node in a graph - traverse it in different ways. For instance: an integer representing the shortest path from a cue to the current token.

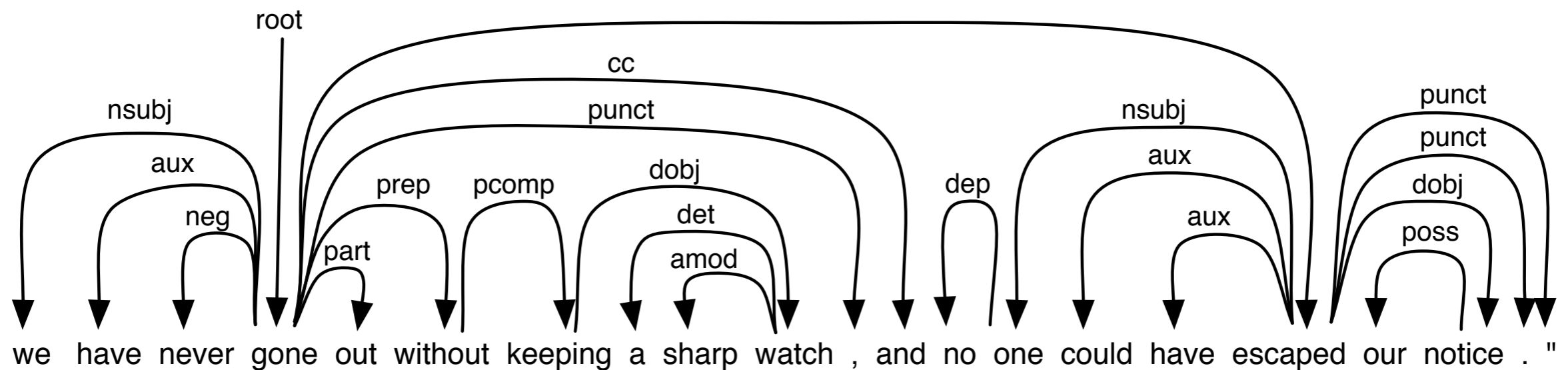
A system for NSR

A closer look



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A system for NSR

A closer look



ACQUIRE
MODEL

Wapiti, a well documented toolkit for sequence classification.

CRF algorithm used to classify sequences. On the to-do list: experiment with other packages/algorithms

Evaluation

- Label-wise Precision, Recall and F-score

$$P = \frac{TP}{TP + FP} \quad R = \frac{TP}{TP + FN} \quad F = \frac{2PR}{P + R}$$

Evaluation

- Label-wise Precision, Recall and F-score

$$P = \frac{TP}{TP + FP} \quad R = \frac{TP}{TP + FN} \quad F = \frac{2PR}{P + R}$$

- Percentage of Correct Scopes (PCS):

Gold: O O O N N N O 

System: O O O O N N O

Gold: O O O N N N O 

System: N O O N N N O

Evaluation

Baseline systems

Product Review

	P	R	F	PCS
Councill et al.	81.9	78.2	80.0	39.8

Councill et al. report on P, R, F for **all** labels, but 'out of scope' accounts for 92% of the corpus. The following tables report P, R and F for 'in scope' only.

cue to end	22.1	99.7	36.2	36.3
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Evaluation

System

	P	R	F	PCS
- syntax - distance	72.2	61.2	66.3	54.3
+ syntax + distance	70.4	69.5	70.0	61.2
- syntax + distance	68.2	68.5	68.4	59.8
+ syntax - distance	72.2	69.8	71.0	61.6
Pseudo-gold cues				
+ syntax - distance	84.1	79.8	81.9	68.0

NSTOP

- (1) Mario is not **tall** <but> he is happy.
- (2) Mario is not **short and sad** <.>
- (3) Mario **doesn't** **only** <jump> and stomp, he spits fire.
- (4) Mario **doesn't** **kill Bowser** <because> they are friends.

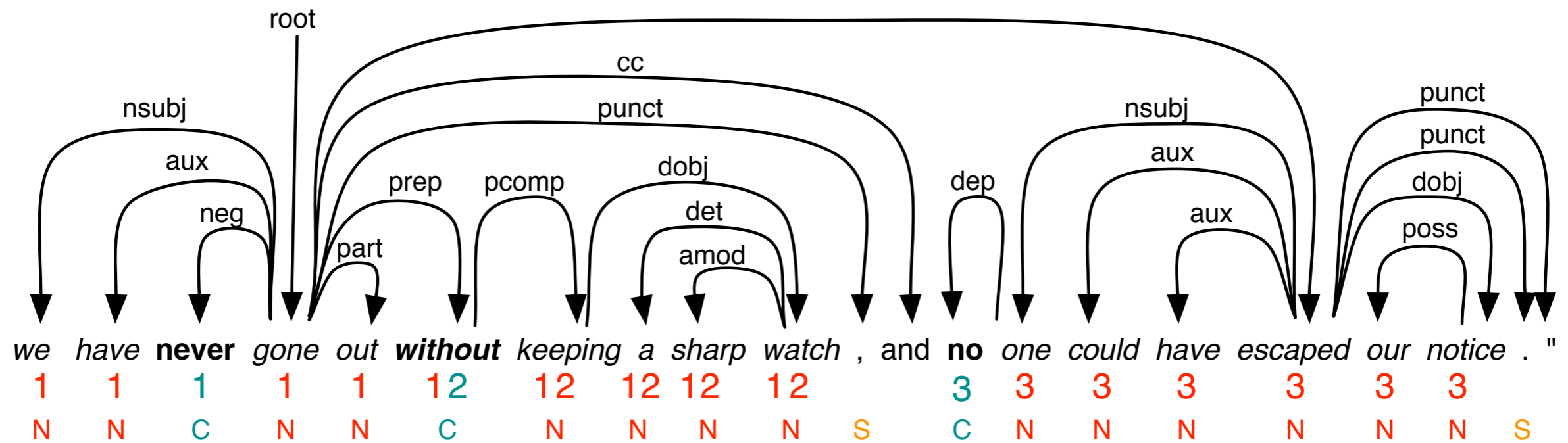
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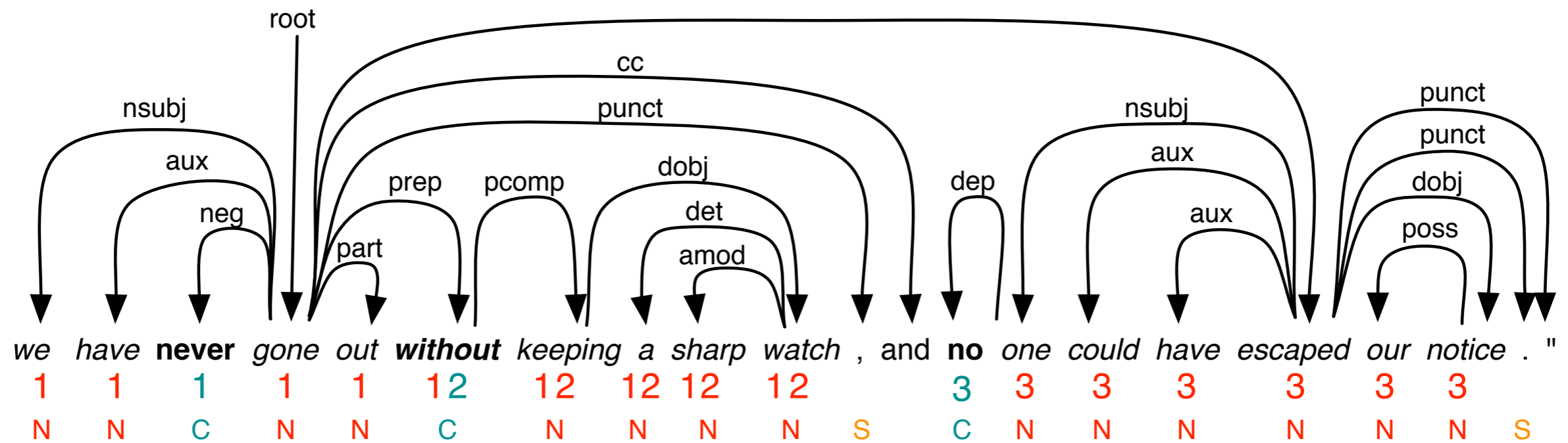
It helps to be explicit!

	P	R	F	PCS
2 labels	72.1	62.6	67.0	52.3
3 labels	72.2	69.8	71.0	61.6

Moving to CD-SCO



Moving to CD-SCO



	P	R	F	PCS
+ syntax	86.1	78.9	82.4	69.1
- distance				

Simplified CD-SCO, gold cues - model from training corpus, tested on development

THANK YOU!

Fin.