A Dutch coreference resolution system with an evaluation on literary fiction

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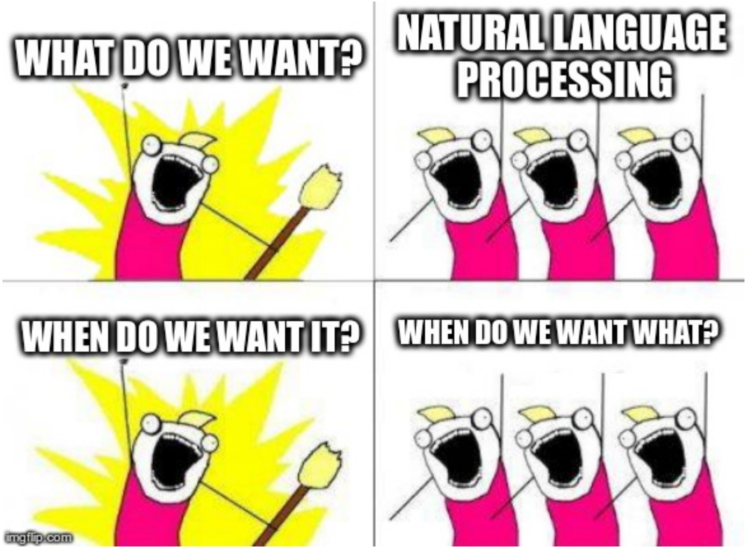
November 7, 2019, Düsseldorf, CL colloquium talk



https://twitter.com/JenMsft/status/1132306345787568128

Plan for today

1. Background
2. Annotating Dutch novels
3. The coreference system
4. Evaluation
5. Future work

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Definition

Coreference resolution is the task of clustering mentions in text that refer to the same underlying real world entities.

http://nlpprogress.com/english/coreference_resolution.html

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```
               +-----------+
               |           |
"I voted for Obama because he was most aligned with my values”, she said.
 |                                                  |            |
 +--------------------------------------------------+------------+
```

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```
               +-----------+
               |           |
"I voted for Obama because he was most aligned with my values", she said.
 |                                                  |            |
 +--------------------------------------------------+------------+
```

- Entity 1 = {Obama, he}
- Entity 2 = {I, my, she}

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Mentions

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Mention or referring expression: span of text that refers to a person or object in the real or mention world.

NB: contrast with markable, a *potentially* referring expression.

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Pronouns	I, he, my, his, that, [each other], himself, . . .
Names	[John], [John Smith], [Mr. Smith], . . .
Nominals	[the man], [the flowers on [the table]], . . .

But not:

- Events, actions, times

Coreference: mentions of the same entity

- [John]$_1$ sees [Mary]$_2$. [He]$_1$ waves at [her]$_2$.
- [Bond]$_1$, [James Bond]$_1$.
- [I]$_1$ took [[my]$_1$ bike]$_2$.

Winograd schemes

The [city councilmen]$_1$ refused [the demonstrators]$_2$ a permit because . . .

1. . . . [they]$_1$ feared violence.
2. . . . [they]$_2$ advocated violence.

“AI-complete” problem

Kehler (2002). Coherence, reference, and the theory of grammar, chapter 1.
http://web.stanford.edu/group/cslipublications/cslipublications/pdf/1575862166.pdf

History of coreference resolution

Various datasets, languages:

1996 MUC-6 shared task, English

2004 ACE shared task, English/Chinese/Arabic

2010 SemEval shared task, multilingual including Dutch

2011 CoNLL shared task, English

2012 CoNLL shared task, English/Chinese/Arabic

State of the art: from rules to a neural arms race …

OntoNotes (English), CoNLL scores:

CoNLL 2011	shared task, winner: Lee et al., rule-based	58.3%
CoNLL 2012	shared task, winner: Fernandes et al., perceptron	58.7%
EMNLP 2017	end-to-end coref. resolution, deep learning	67.2%
NAACL 2018	e2e + ELMO + c2f, deeper learning	73.0%
EMNLP 2019	e2e + BERT Large, even deeper learning	76.9%

Evaluation metrics

Coreference evaluation is a mess!

Fatally flawed metrics:

1996 MUC

1998 B^3

2005 CEAFm, CEAFe

2011 CoNLL score (= avg of MUC, B^3, CEAFe)

2011 BLANC

No known issues (yet!):

2016 Link-based Entity-Aware metric (LEA)

Moosavi & Strube (ACL 2016) Which coreference evaluation metric do you trust?
A proposal for a link-based entity aware metric

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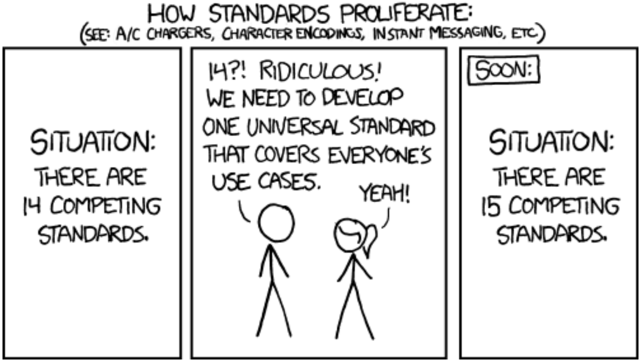
By the way . . .

#BenderRule:

The rest of this talk is about Dutch!

https://thegradient.pub/the-benderrule-on-naming-the-languages-we-study-and-why-it-matters/

I made a new annotation scheme . . .


HOW STANDARDS PROLIFERATE:
(SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC)
SITUATION: THERE ARE 14 COMPETING STANDARDS.
14?! RIDICULOUS! WE NEED TO DEVELOP ONE UNIVERSAL STANDARD THAT COVERS EVERYONE'S USE CASES.
YEAH!
SOON:
SITUATION: THERE ARE 15 COMPETING STANDARDS.

https://xkcd.com/927/

Annotation scheme

Simplified annotation scheme:

- Annotate mentions: include singletons, exclude non-referring expressions.
- Avoid difficult mention boundaries: no discontinuity, relative clauses
- Only annotate entity clusters, not directed anaphor-antecedent relations

`https://github.com/andreasvc/dutchcoref/`

Annotation workflow

1. Tokenize, parse with Alpino
2. Run coreference system
3. Manually correct output with CorefAnnotator
4. Optional: correction by second annotator

`http://www.let.rug.nl/vannoord/alp/Alpino/`
`https://github.com/nilsreiter/CorefAnnotator/`

Annotation workflow

1. Tokenize, parse with Alpino
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Result: tabular CoNLL 2012 file

```
#begin document (example); part 000
example 1    John       (0)
example 2    sees       -
example 3    Mary       (1)

#end document
```

http://www.let.rug.nl/vannoord/alp/Alpino/
https://github.com/nilsreiter/CorefAnnotator/

Annotated texts

	CLIN26 dev set	SemEval 2010 dev	Novels, dev set	Novels, test set
documents	30	23	10	11
tokens	4018	9164	19,051	88,092
sents per doc	7	21.4	100	491.5
avg sent len	19.3	18.4	19.0	16.3

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sents per doc	7	21.4	100	491.5
avg sent len	19.3	18.4	19.0	16.3
entities	273	424	1798	8337
mentions	663	1010	4243	20,873
% pronouns	7.69	14.45	43.3	36.5
% nominal	52.34	54.35	46.2	52.2
% names	39.97	31.20	10.5	11.2

107k tokens of annotated literary text!

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Mention detection

1. Extract candidate constituents	► [John], [who], [the book on [the table]], . . .
2. Adjust spans	► [Mr Smith], [San Jose, California], . . .
3. Filter with patterns	► Drop: yesterday, about two meters, . . .
4. Detect features	► gender, animacy, number

Mention feature detection

parse	features in the Alpino parse tree (HPSG-inspired)
NER	part of Alpino; person/org/loc/misc
wordnet	animacy & gender of head nouns (hand-corrected)
web text	names extracted w/heuristic patterns from 30GB English text

Bergsma & Lin (COLING-ACL 2006). Bootstrapping path-based pronoun resolution.
`http://aclweb.org/anthology/P06-1005`

Mention feature detection

parse features in the Alpino parse tree (HPSG-inspired)

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	Pronouns	Nominals	Names
Number	parse	parse	web tekt
Gender	parse	wordnet	web text
Animacy	parse	wordnet	NER, web text

Bergsma & Lin (COLING-ACL 2006). Bootstrapping path-based pronoun resolution.
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Sieves: link mentions with deterministic rules

Quote attribution find speaker & addressee of direct speech

String match [The boy]$_1$ … [The boy]$_1$ …

Precise constructs [the boy]$_1$ [who]$_1$ …

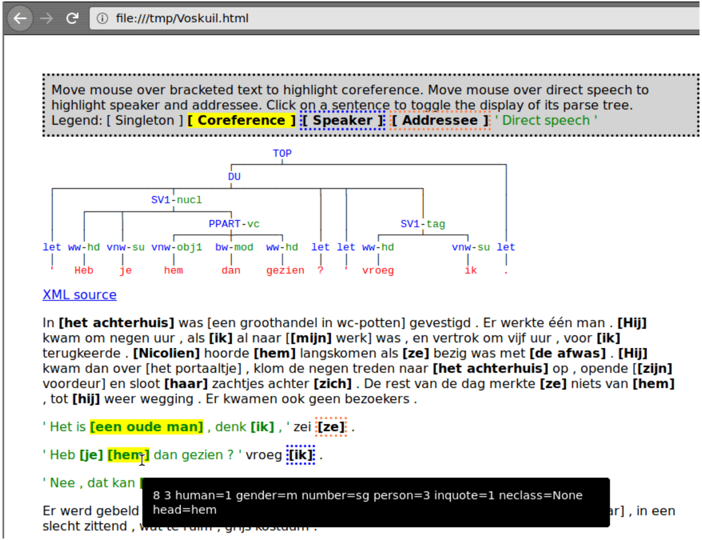
Head match [The clever boy]$_1$ … [the boy]$_1$

Proper head noun match [Bond]$_2$, [James Bond]$_2$

Pronoun resolution [He]$_1$ … [his]$_1$ …

Muzny et al. (EACL 2017) A two-stage sieve approach for quote attribution
Heeyoung Lee et al. (CL 2013) Deterministic coreference resolution […]

Demo



file:///tmp/Voskuil.html

Move mouse over bracketed text to highlight coreference. Move mouse over direct speech to highlight speaker and addressee. Click on a sentence to toggle the display of its parse tree.
Legend: [Singleton] **[Coreference]** **[Speaker]** **[Addressee]** ' Direct speech '

XML source

In **[het achterhuis]** was [een groothandel in wc-potten] gevestigd . Er werkte één man . **[Hij]** kwam om negen uur , als **[ik]** al naar [**[mijn]** werk] was , en vertrok om vijf uur , voor **[ik]** terugkeerde . **[Nicolien]** hoorde **[hem]** langskomen als **[ze]** bezig was met **[de afwas]** . **[Hij]** kwam dan over [het portaaltje] , klom de negen treden naar **[het achterhuis]** op , opende [**[zijn]** voordeur] en sloot **[haar]** zachtjes achter **[zich]** . De rest van de dag merkte **[ze]** niets van **[hem]** , tot **[hij]** weer wegging . Er kwamen ook geen bezoekers .

' Het is **[een oude man]** , denk **[ik]** , ' zei **[ze]** .

' Heb **[je]** **[hem]** dan gezien ? ' vroeg **[ik]** .

' Nee , dat kan [

8 3 human=1 gender=m number=sg person=3 inquote=1 neclass=None head=hem

Er werd gebeld ar] , in een slecht zittend , wat te ruim , grijs kostuum .

https://andreasvc.github.io/voskuil.html

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Evaluation: shared tasks

CLIN26 shared task	Mentions	BLANC
GroRef, Boeing test set	59.34	30.96
This Work, Boeing test set	**59.49**	**31.48**
GroRef, GM test set	**60.40**	**31.31**
This Work, GM test set	59.26	31.07
GroRef, Stock test set	53.70	25.40
This Work, Stock test set	**54.68**	**26.09**

SemEval 2010, Dutch, test set	Mentions	BLANC	MUC	B^3	CEAFm
SemEval 2010: Sucre	42.3	**46.9**	29.7	11.7	15.9
SemEval 2010: UBIU	34.7	32.3	8.3	17.0	17.0
This Work	**64.27**	41.48	**51.95**	**45.85**	**51.20**

Evaluation: novels

	mention			LEA
	F1	recall	precision	F1
SemEval 2010 (test set)	64.27	36.00	39.96	37.88
CLIN26 shared task (Boeing test set)	59.49	29.83	33.95	31.76
Literary texts (dev set)	87.05	57.13	61.71	59.33
Literary texts (test set)	87.10	49.27	57.45	53.05

Discussion

- High variance among novels; matter of style?
- Better performance on novels than news! Surprising?
  - More dialogue and pronouns in novels (some long chains)
  - Novels are longer documents
    (including our annotated fragments)
  - Not all errors are created equal . . .

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Improve components

Components:

- Mention detection/spans
- Pleonastic pronoun detection
- Gender/animacy
- Quote attribution
- Pronoun resolution

Heeyoung Lee et al. (NLE 2017) A scaffolding approach to coreference resolution integrating statistical and rule-based models. `https://doi.org/10.1017/S1351324917000109`

Improve components

Components:

- Mention detection/spans
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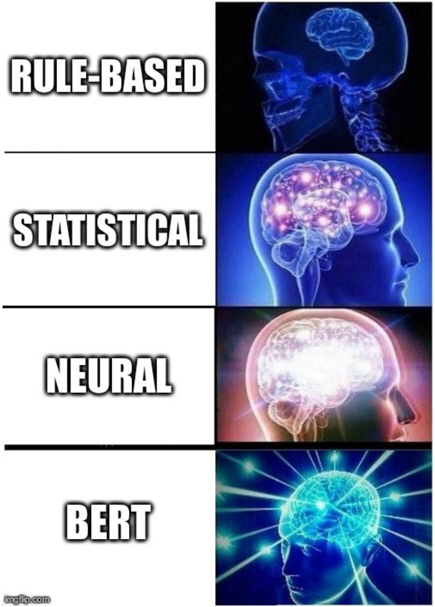
Procedure:

1. Acquire/annotate more data
2. Train supervised classifier
3. ???
4. Profit!

Heeyoung Lee et al. (NLE 2017) A scaffolding approach to coreference resolution integrating statistical and rule-based models. `https://doi.org/10.1017/S1351324917000109`

Neural coreference

Train
End-to-end coreference system
with BERT
for Dutch . . .



Kenton Lee et al. (EMNLP 2017) End-to-end neural coreference resolution

THE END

Code: `https://github.com/andreasvc/dutchcoref`

Paper: Coming soon™

Thanks to my BSc thesis students for helping with annotation!

THAT'S OUR NEW "STRATEGIC DIVERSIFICATION FUND."
OUR LAWYERS PUT YOUR MONEY IN LITTLE BAGS, THEN WE HAVE TRAINED DOGS BURY THEM AROUND TOWN.
DO THEY BURY THE BAGS OR THE LAWYERS?
WE'VE TRIED IT BOTH WAYS.
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