Distributional Semantics for Resolving Bridging Mentions

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What is coreference?

Noun phrases are coreferent if they refer to **the same entity**.

? ? ?

[President Obama] leaves [the White House]. [He] answers [[the press's] questions].

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What are Bridging Mentions?

Congress passed the bill in 1998. Albeit the measure was …

What is Distributional Semantics?

The **Distributional Hypothesis** in linguistics is the theory that words that occur in similar contexts tend to have similar meanings.
(Harris, 1954)

Z. Harris. (1954). Distributional Structure. Word 10 (2/3)

Use Distributional Semantics
for Bridging Mentions

Congress passed the bill in 1998. Albeit the measure was …

bill	measure
legislation	legislation
amendment	bill
measure	amendment
proposal	initiative
ordinance	proposal
resolution	ordinance

Outline

- Coreference Resolution
  - Berkeley System
  - Problems

- New Semantic Features

- Evaluation

- Error Analysis

Berkeley (Durrett/Klein 2013)

- considers **all** mention pairs (training and classification)

- log linear classifier over latent antecedents

[President Obama] leaves [the White House]. [He] answers [the questions].

m_1 m_2 m_3 m_4
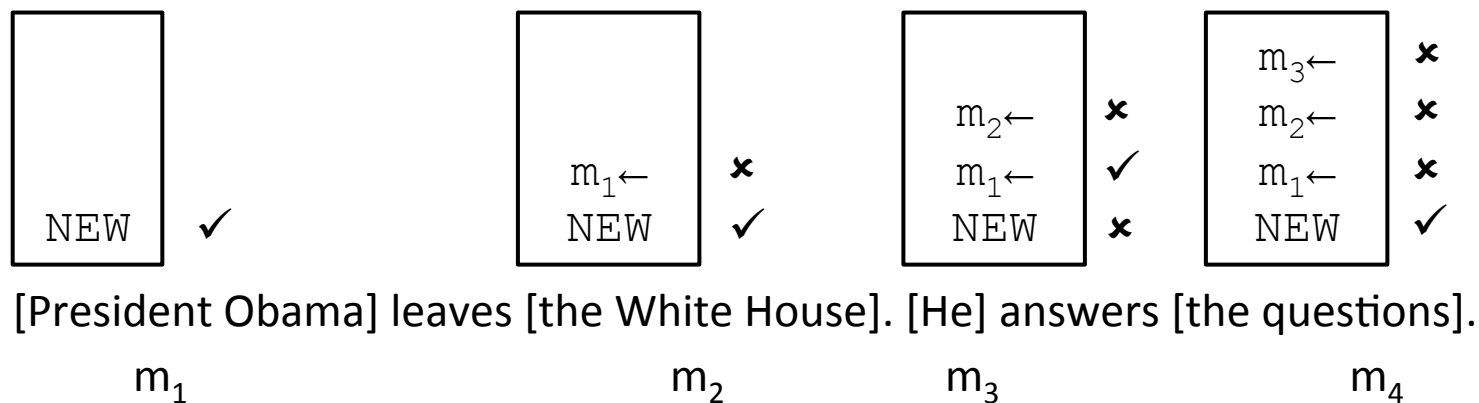
Greg Durrett and Dan Klein. 2013. Easy victories and uphill battles in coreference resolution.
In *Proc. EMNLP*, pages 1971–1982, Seattle, WA, USA.

Is it any good?

- Highest scores for metrics MUC, B^3 und $CEAF_e$ on current (CoNLL 2011 shared task) data
- **But only shallow semantics**

[Acme inc.] presented [[the company]'s first mobile phone].

ORGANIZATION

{Acme inc., the company}, {the company's first mobile phone} ✓

Barack Obama visited France. The President liked the country.

{Barack Obama}, {France}, {The President}, {the country} ✗

New Semantic Features (PICA)

- **P**rior: Based on Distributional Thesauri

- **I**S-A: Features based on IS-A patterns

- **C**ontext: Dependency based Prior

- **A**ttribute: Pattern Based Prior & IS-A Features

Prior Features

DT Expansions

study#NN
survey#NN
analysis#NN
report#NN
audit#NN

2

[**A market study**] indicates that Hong Kong consumers are the most materialistic in the 14 major markets where [**the survey**] was carried out.

survey#NN
poll#NN
study#NN
report#NN
statistic#NN

3

DT Expansions

Rank

Overlap

Prior(study,survey)=2
Prior(survey,study)=3
SharedPrior(study,survey)=3/5=0.6
SharedPrior(survey,study)=3/5=0.6

IS-A Features

IS-As

way
step
program
effort
issue

[**A market study**] indicates that Hong Kong consumers are the most materialistic in the 14 major markets where [**the survey**] was carried out.

step
bit
way
document
tool

IS-As

SHARED-IS-A(t1,t2)=2/5

IS-IS-A(t1,t2)=t1∈IS-AS(t2)

IS-IS-A(t1,t2)=false
IS-IS-A(t2,t1)=false

Context

Context

Rank DT entries according to dependencies of head words

study#NN
survey#NN
research#NN
message#NN
move#NN

det
nn
nsubj

[A market study] indicates that Hong Kong consumers are the most materialistic in the 14 major markets where [the survey] was carried out.

det
nsubjpass
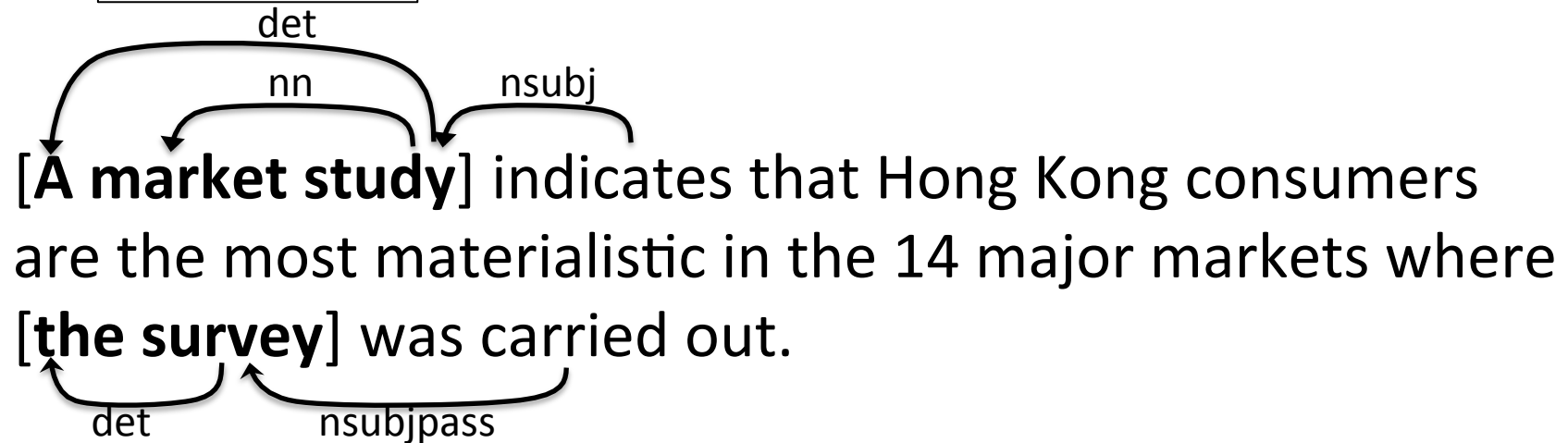
attack#NN
that#WDT
which#WDT
test#NN
examination#NN

Context

Rank

Overlap

ContextPrior(study,survey)=2
ContextPrior(survey,study)= - 1
ContextSharedPrior(study,survey)=0
ContextSharedPrior(survey,study)=0

Attribute

- Use "patterns" (Vieira, 2000) to find attributes used for PRIOR and IS-A Features for expansions
  - Copula:
    - [Sokrates] was a <u>human</u>
  - Apositive:
    - [The <u>painter</u> Matisse]

Renata Vieira and Massimo Poesio. 2000. An empirically based system for processing definite descriptions. *Computational Linguistics*, 26(4):539–593.

Experimental Setting

- CoNLL-2011 Co-reference task
  - 2999 documents from OntoNotes
- Distributional Thesaurus[1]
  - 120M sentences of Newspaper
  - Syntactic dependencies for context
- Compare to Bansal & Klein Semantic Features

[1] computed using JoBimText (https://jobimtext.org)

Mohit Bansal and Dan Klein. 2012. Coreference semantics from web features. In *Proc. ACL*, pages 389–398, Jeju Island, Korea.

Bansal & Klein Features

- Features extracted from Google Web-Ngrams
  - IS-A Features: Same as our features

  - Co-occurrence of target words

  - Entity based context using patterns:
    ```
    x (is|are|was|were) (a|an|the)? Y
    ```
    use best performing feature combination

  - Phrasal Clusters proposed by Lin 2010

Dekang Lin, Kenneth Ward Church, Heng Ji, Satoshi Sekine, David Yarowsky, Shane Bergsma, Kailash Patil, Emily Pitler, Rachel Lathbury, Vikram Rao, et al. 2010. New tools for web-scale n-grams. In *Proc. LREC*, Valletta, Malta.

Results

Test Set	MUC			BCUBED			CEAFE			AVG
	P	R	F1	P	R	F1	P	R	F1	
Berkeley	**69.69**	65.98	67.79	**58.68**	53.59	56.02	54.31	53.88	54.09	59.30
+Bansal&Klein	69.30	66.11	67.67	58.10	53.62	55.77	54.31	53.63	53.97	59.14
PICA Features	69.17	**66.87†**	**68.00**	57.77	**54.49†**	**56.08**	**54.45**	**54.44†**	**54.44**	**59.51**

† significant improvement to Berkley system based on paired bootstrap resampling test with p=0.05

Results – Bridging Mentions

Test Set	Precision	Recall	F1
Berkeley	38.06	17.32	23.81
+ Bansal & Klein	37.97	21.56†	27.50†
+ our features	**39.47**	27.05†	**32.10†**
+ B & K and our features	36.84	**27.33†**	31.38†

† significant improvement to Berkley system based on paired bootstrap resampling test with p=0.05

The good, the bad, and the ugly

Hookers received a $ 409 million bid […]. The offer doesn't include …

Those measures… It…

…said her father. The mother…   → Reason for low precision

Conclusion

- Semantic Features ...

  - ... help only partial for Coreference Resolution
    - But we observe significant improvements

  - ... help for bridging mentions

I would like to thank [the RANLP participants] for being [attendees] at this talk!

participant#NN

attendee#NN

participate#VB

participation#NN

guest#NN

student#NN

spectator#NN

volunteer#NN

visitor#NN

entrant#NN

attendee#NN

participant#NN

visitor#NN

guest#NN

specator#NN

goer#NN

delegate#NN

exhibitor#NN

resident#NN

organizer#NN