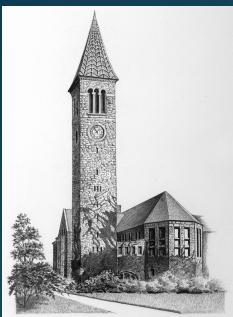


Claire Cardie
Cornell University
Departments of Computer Science
and Information Science

Keeping Apace with Progress in Natural Language Processing



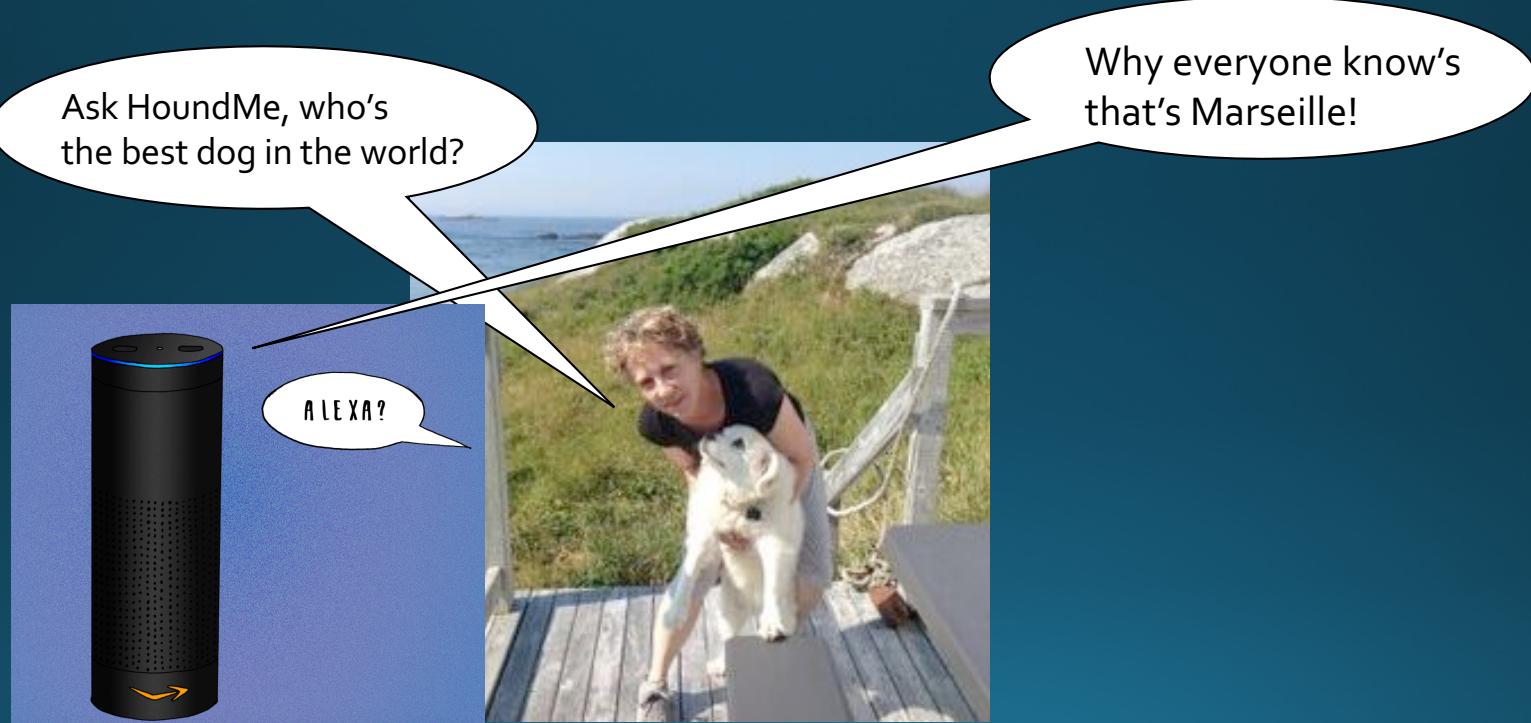
Explosion of high-profile NLP systems



Explosion of high-profile NLP systems

The screenshot shows the Google Translate interface. At the top, there are language selection boxes: the left one shows "English", "Spanish", "French", and "English - detected" with a dropdown arrow; the right one shows "English", "French", "Lao", and a dropdown arrow. Below these are two text boxes. The left text box contains the English sentence: "Ninety-seven companies, from Apple to Zynga, filed an impassioned legal brief condemning President Donald Trump's executive order on immigration, stepping up the industry's growing opposition to the policy." The right text box contains the French translation: "Quatre-vingt-dix-sept sociétés, d'Apple à Zynga, ont déposé un mémoire légal condamnant l'ordonnance du président Donald Trump sur l'immigration, intensifiant l'opposition croissante de l'industrie à la politique." Between the text boxes are several small icons: a double arrow, a star, a square, a double arrow, and a share symbol. At the bottom right of the right text box is a "Suggest an edit" button.

Explosion of high-profile NLP systems



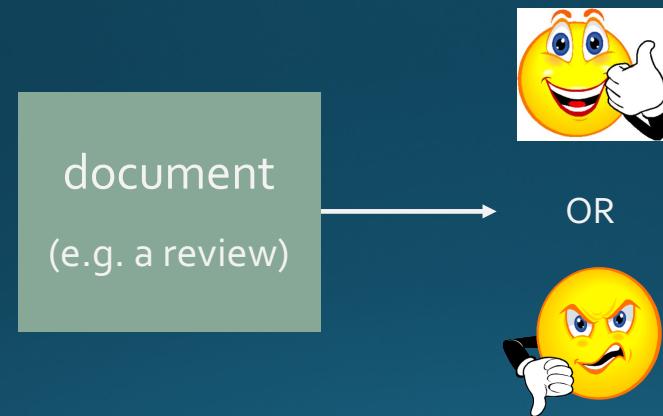
Aim of this talk

- Present (just a few of) the key research trends in NLP*
- What is on the horizon

*examining them via one of the subareas I'm most familiar with

Opinion analysis

Sentiment analysis



See books: Pang & Lee (2008)
and (for reviews) Liu (2012)

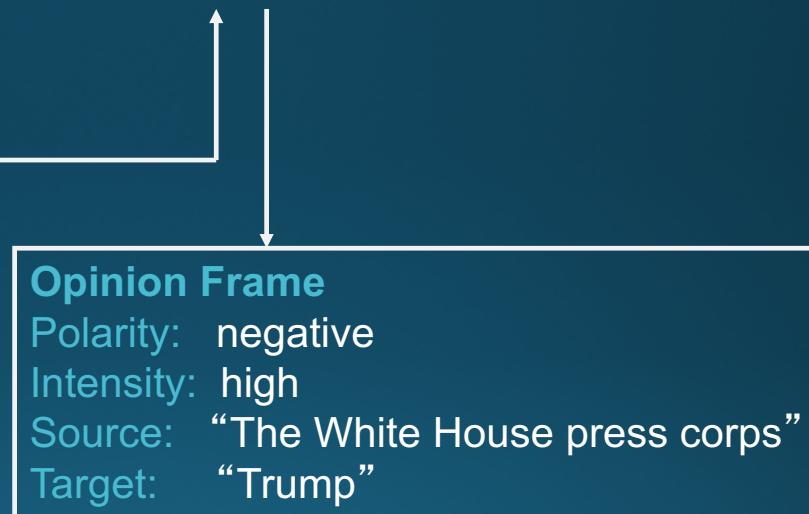
Fine-grained opinion extraction

- Identify any expression of a *private state*, i.e. internal mental or emotional state
 - Speculations
 - Beliefs
 - Emotions
 - Evaluations
 - Goals
 - Judgments
 - Opinions
 - ...

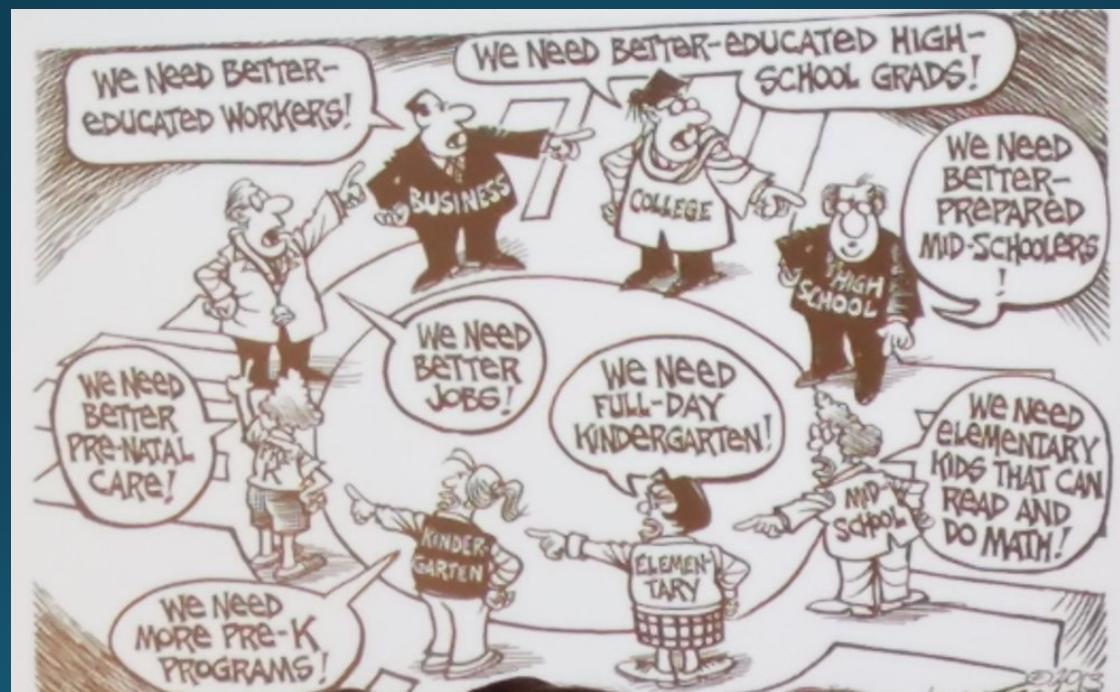
Fine-grained opinion extraction

The White House press corps **launched a bitter attack** on Trump...

- Opinion frame
 - Opinion trigger
 - Polarity
 - positive
 - negative
 - neutral
 - Strength/intensity
 - low..extreme
 - Source (opinion holder)
 - Target (topic)

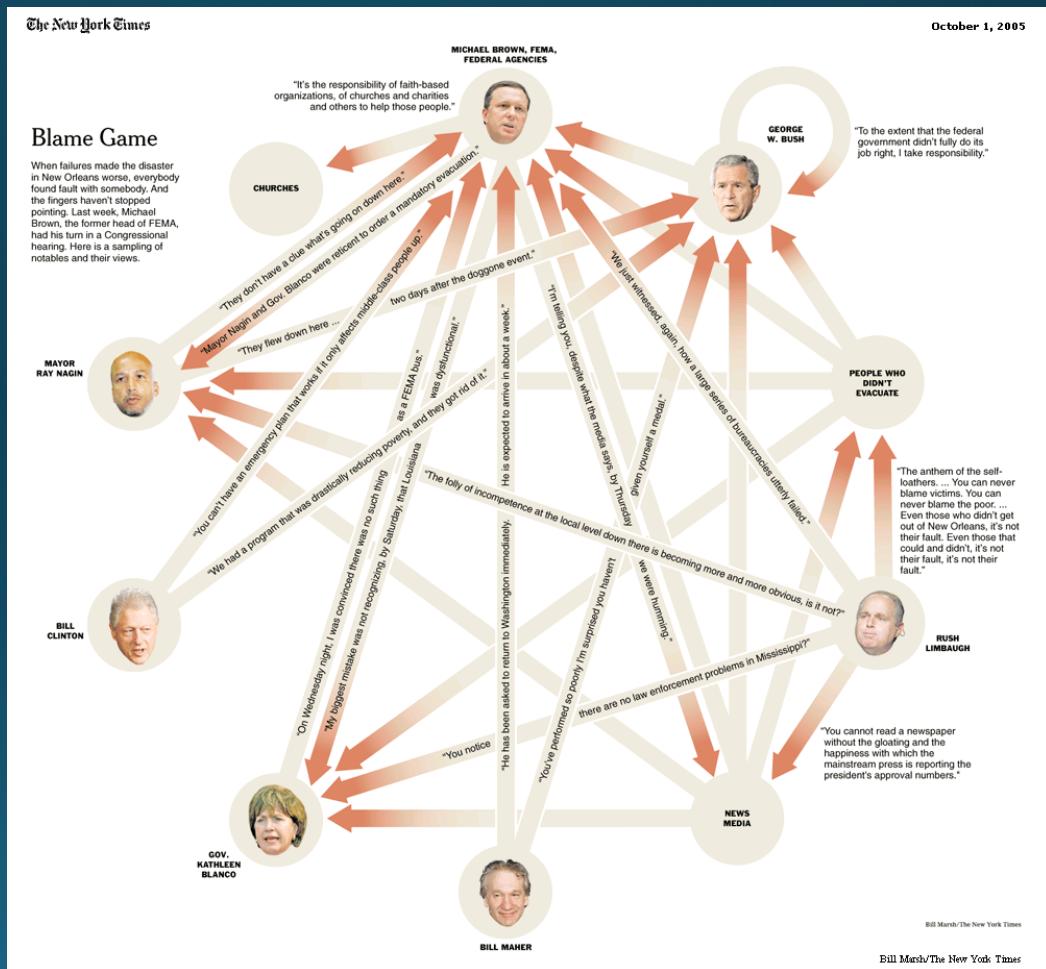


Why?



Why?

Negative opinions
To/from: key players
About: failed emergency relief efforts following hurricane Katrina hit New Orleans in 2005.



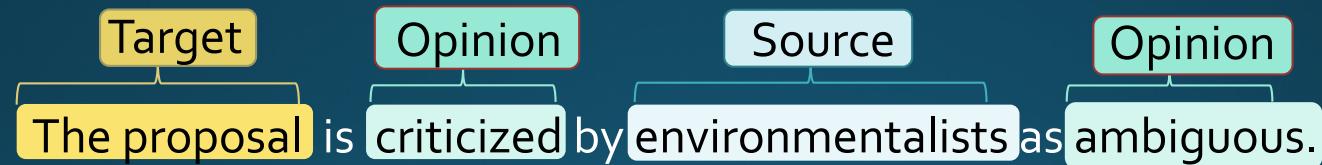
Methods

- Sequence tagging

The proposal is criticized by environmentalists as ambiguous.

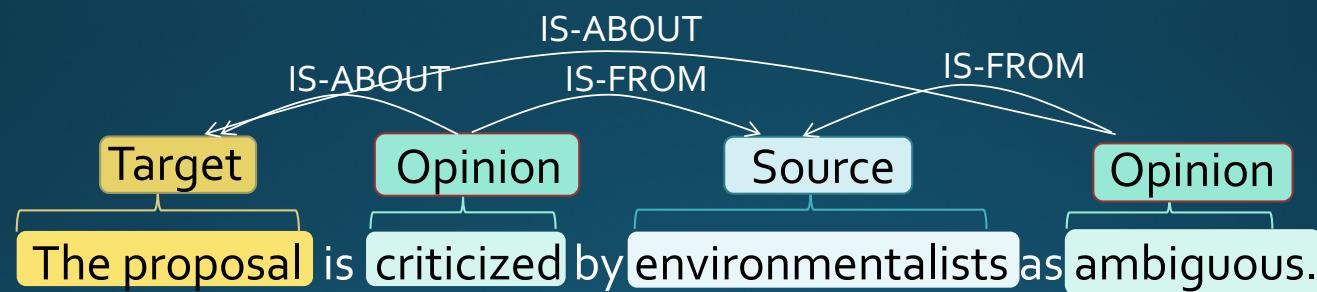
Methods

- Sequence tagging



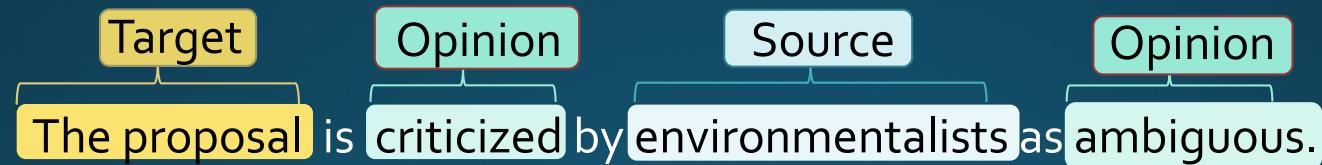
Methods

- Sequence tagging



Methods

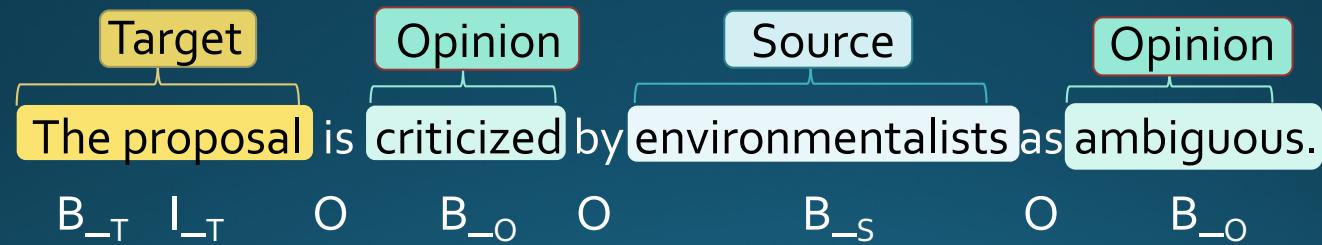
- Sequence tagging



Methods

- Sequence tagging

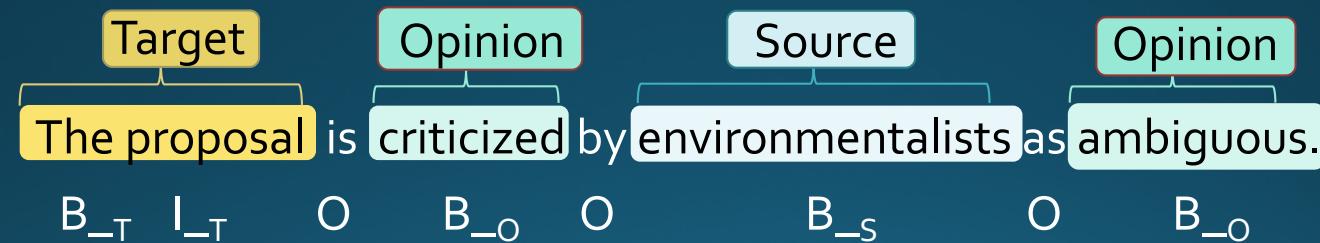
Token-level



Methods

- Sequence tagging via, e.g., CRFs [Lafferty et al., 2001]

Token-level



Methods

- Sequence tagging

The proposal is criticized by environmentalists as ambiguous.

Methods

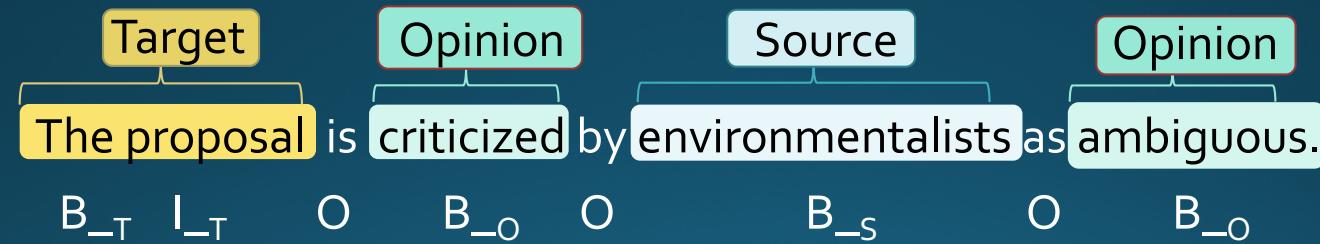
- Sequence tagging

The proposal is criticized by environmentalists as ambiguous.

CRF: B_T I_T O B_O O B_S O B_O

Methods

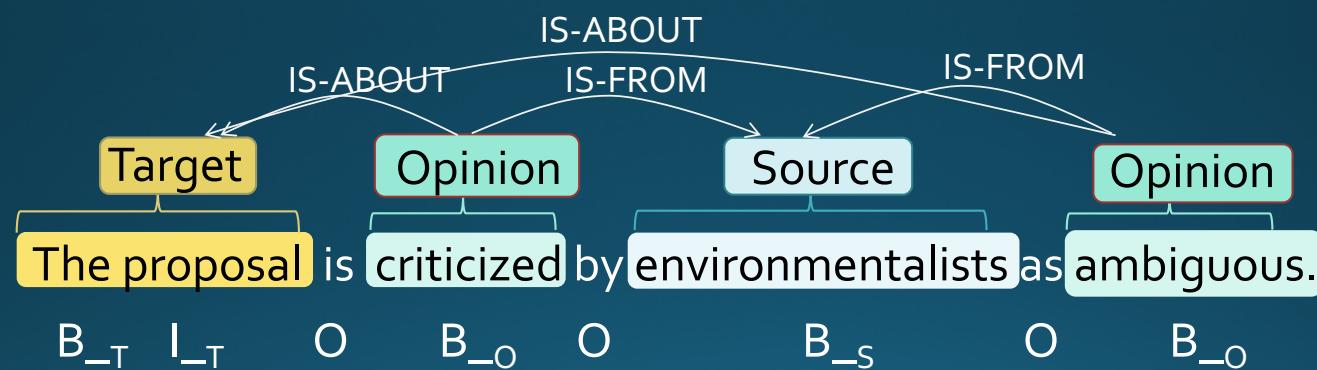
- Sequence tagging
- + classification



Methods

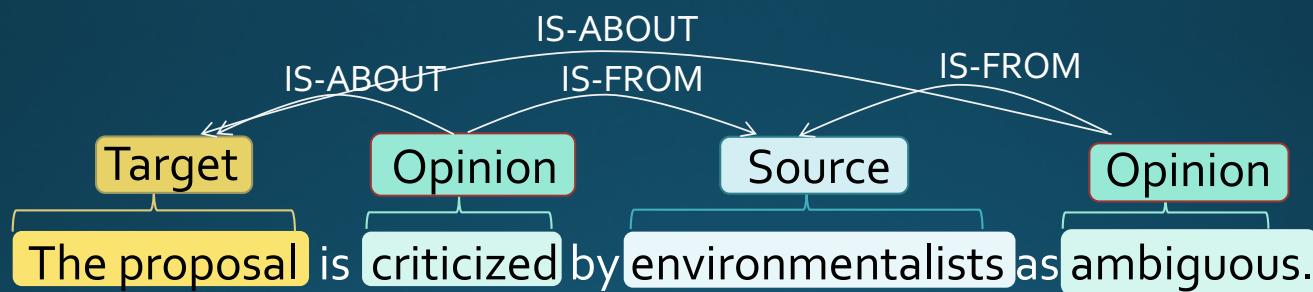
Joint learning models

- Sequence tagging
- + classification



Methods

- Sequence tagging
- + classification



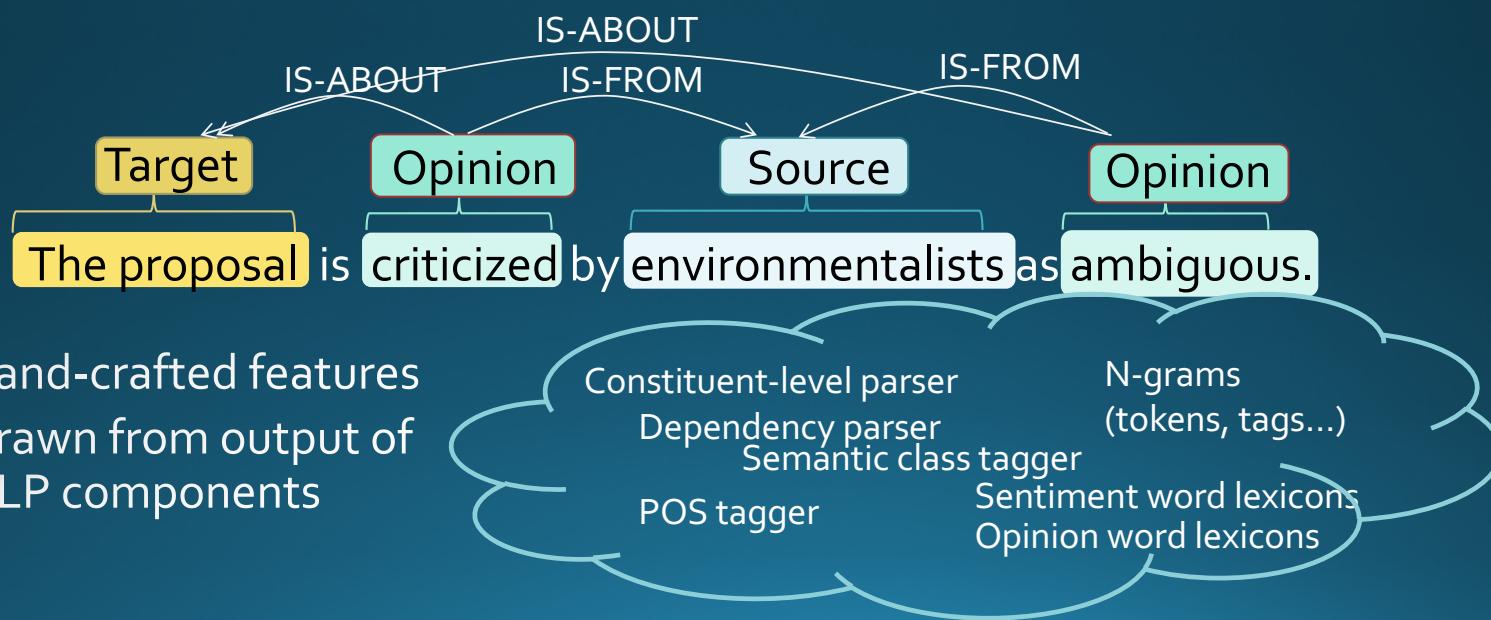
- Hand-crafted features

[Yang & Cardie, ACL2013]

Methods

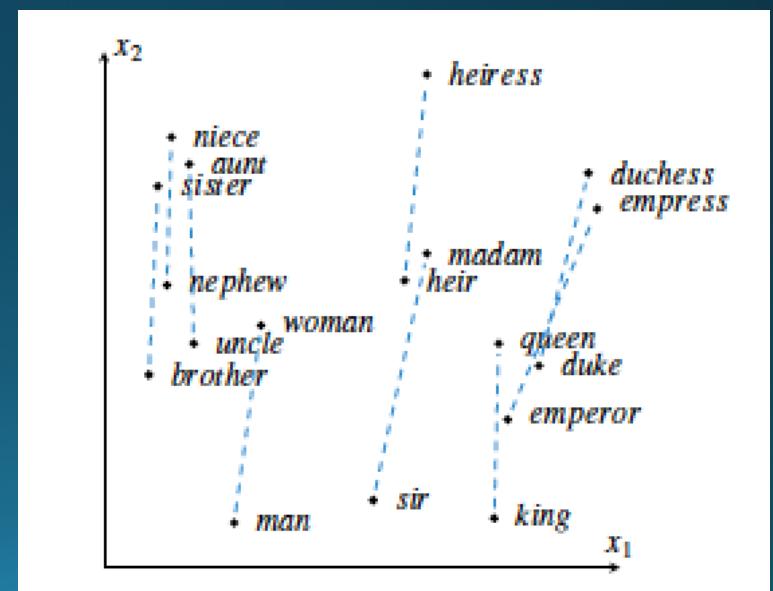
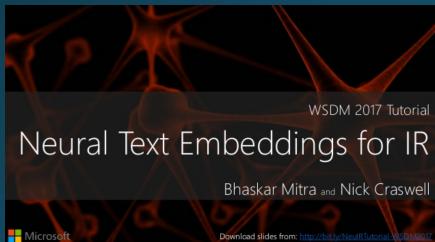
- Sequence tagging
- + classification

opinion exprs	74.3 F (overlap)
IS-FROM	62.6 F
IS-ABOUT	57.0 F



Trend: Word Embeddings

- Short dense vector representation for words
- Goal: words used in similar contexts represented as similar vectors
- Learned in an unsupervised fashion
- Pre-trained WEs are available
 - Word2vec [Mikolov et al. NIPS2013]
 - Glove [Pennington et al. EMNLP2015]



Trend: Word Embeddings

Nearest words to **frog**:

1. frogs
2. toad
3. litoria
4. leptodactylidae
5. rana
6. lizard
7. eleutherodactylus



litoria



leptodactylidae



rana

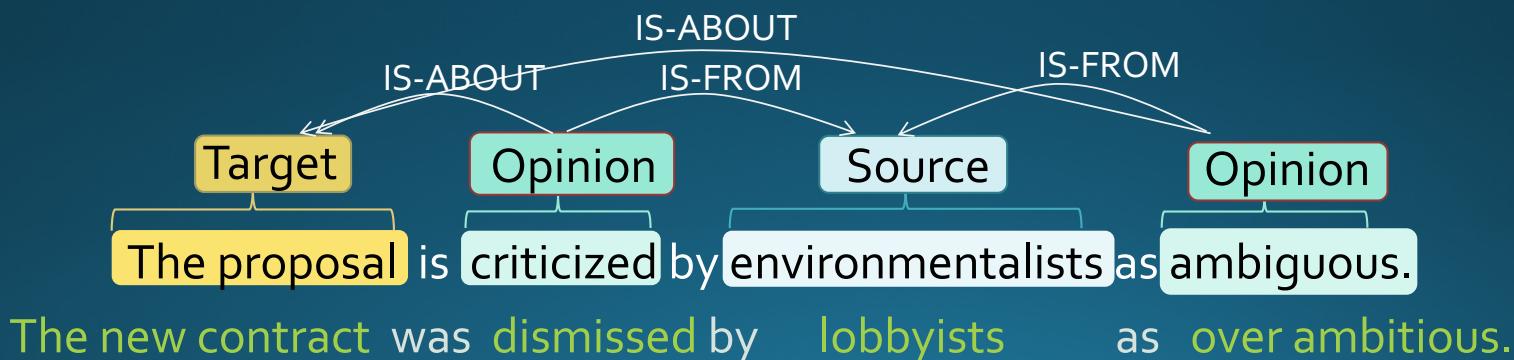


eleutherodactylus

<http://nlp.stanford.edu/projects/glove/>

Trend: Word Embeddings

- Why are they useful?
 - Words (as ML features): no longer just atomic symbols
 - Alleviate data sparsity problem
 - Allow for much better generalization



Trend: Word Embeddings

+2% F
Better recall
MUCH better precision

- Uniformly and measurably improve performance on pretty much all NLP tasks!!!!
- Where have they been used?

Word embeddings are the “Sriracha sauce of NLP”. You can add them to anything to make it better.

- Manning (NAACL tutorial, 2015)

Bilingual word embeddings

- Encode semantic relatedness between words across languages
 - Trained on parallel corpora (best)
 - Now possible to train on **little or no** parallel data [Gouws et al., ICML2015; Vulić and Moens, ACL2015]

Sentiment classification



No sentiment labels
No sentiment lexicons
No NLP components
No MT system

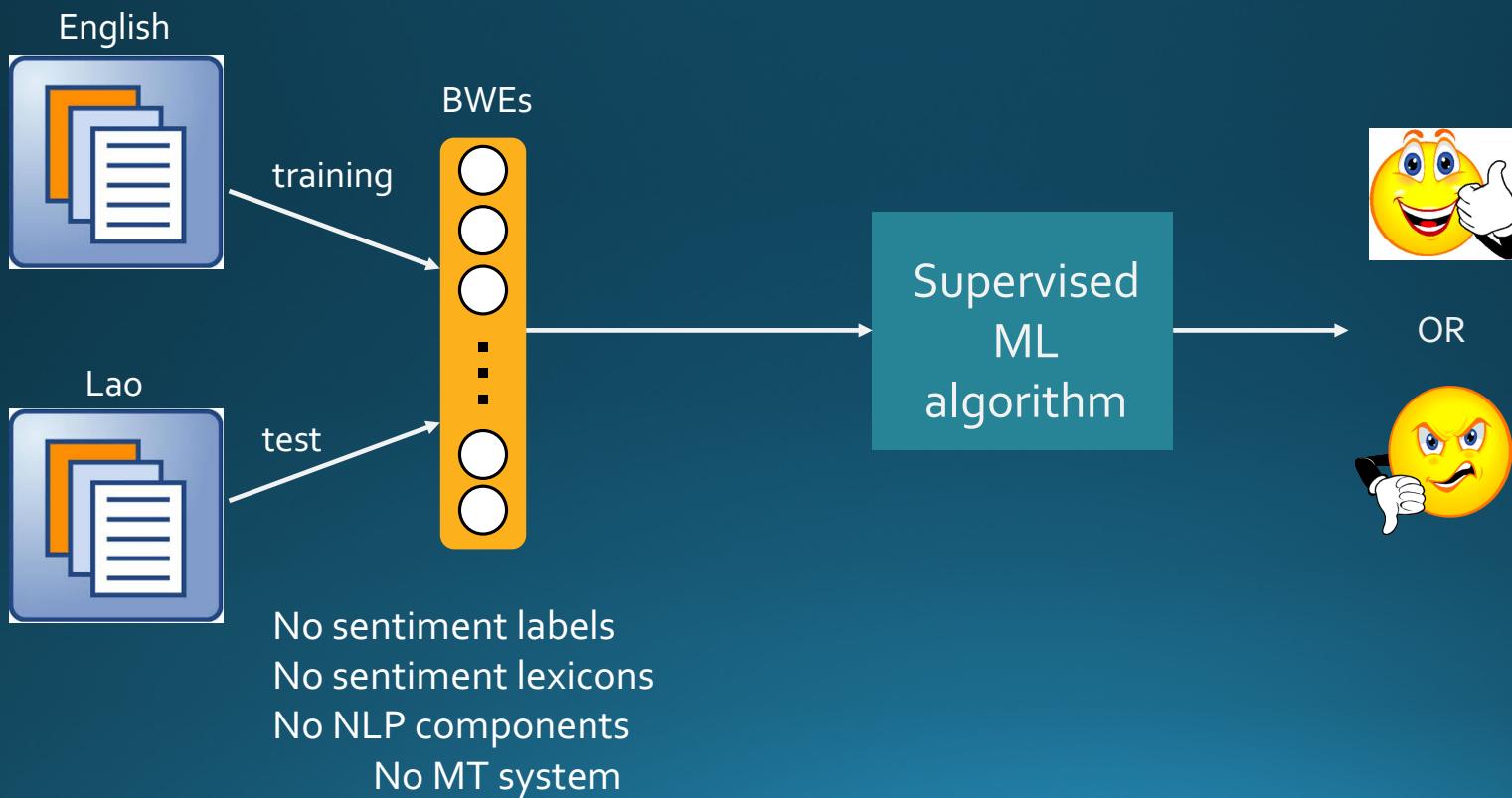
Supervised
ML
algorithm



OR

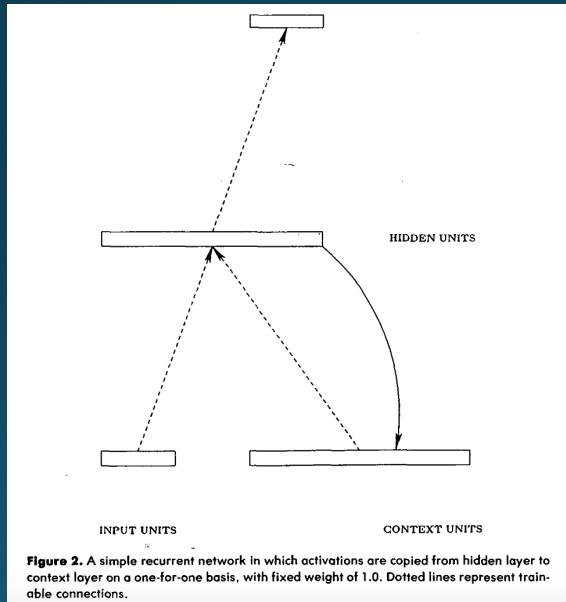


Sentiment classification

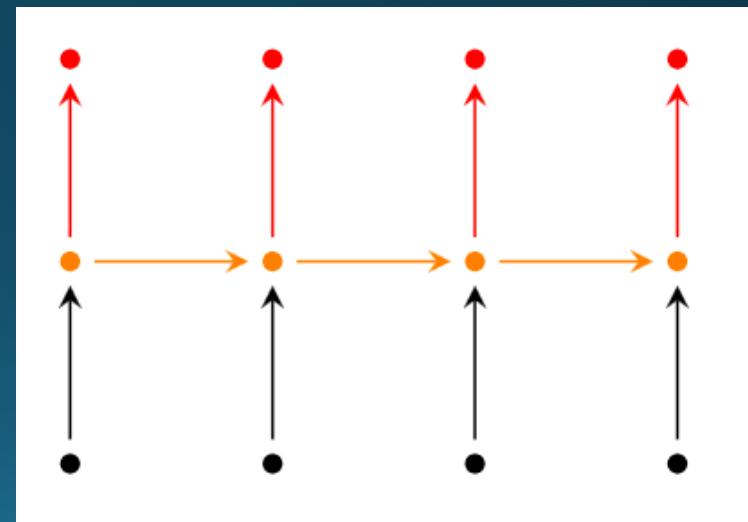


Trend: Recurrent Neural Nets (RNNs)

- Neural network approach to sequence tagging



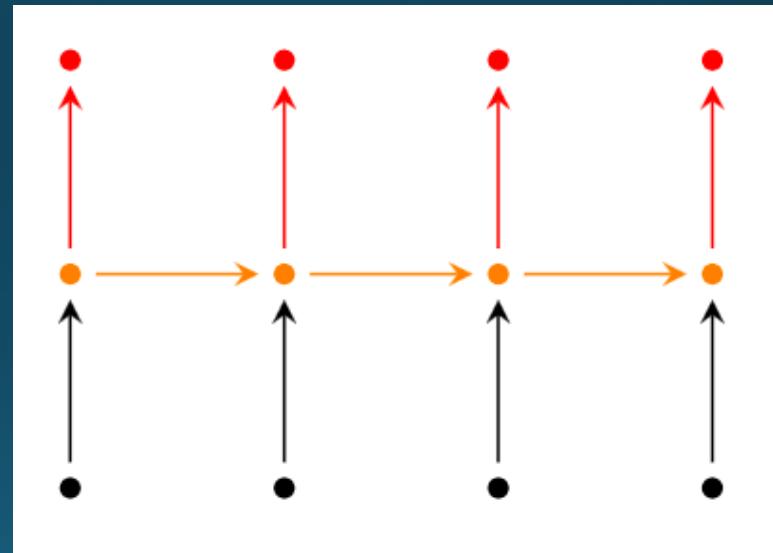
Elman (1990)



RNN unfolded in time

Trend: RNNs

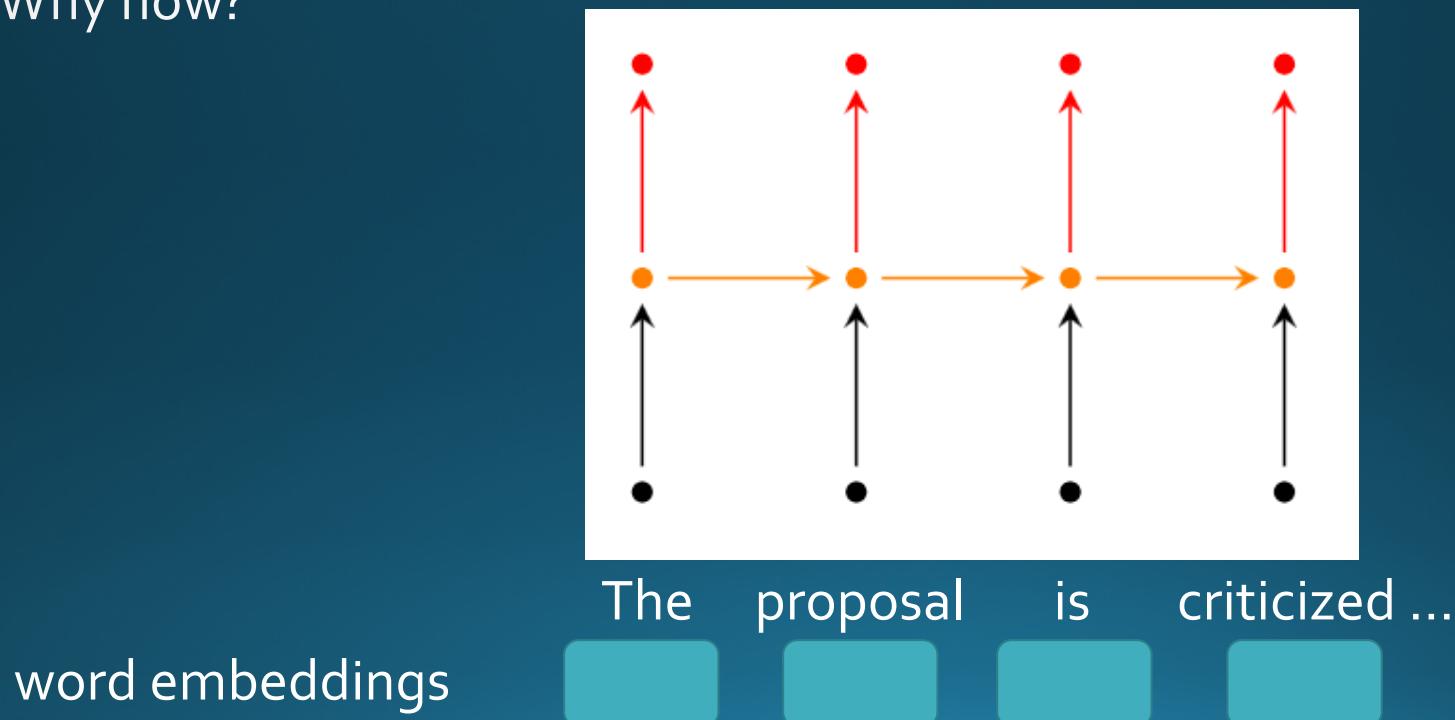
- Why now?



The proposal is criticized ...

Trend: RNNs + Word Embeddings

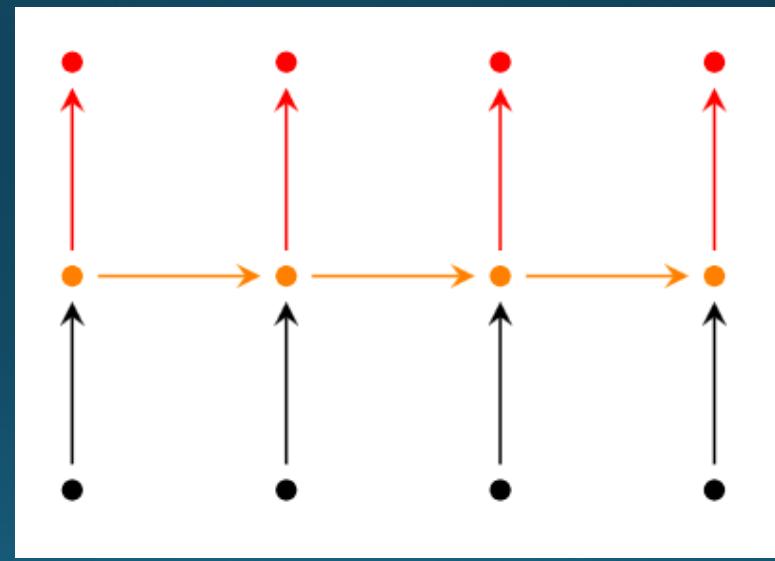
- Why now?



Trend: RNNs + Word Embeddings

- Many powerful variations

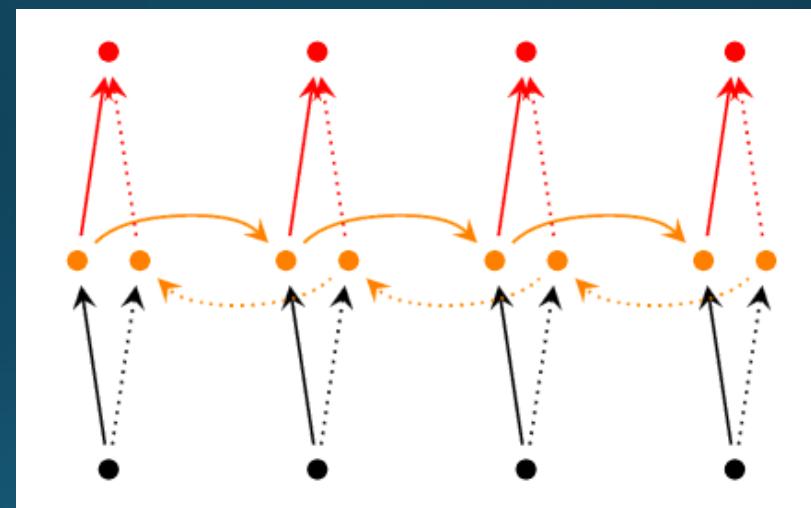
word embeddings



The proposal is criticized ...

Trend: RNNs + Word Embeddings

- Many powerful variations

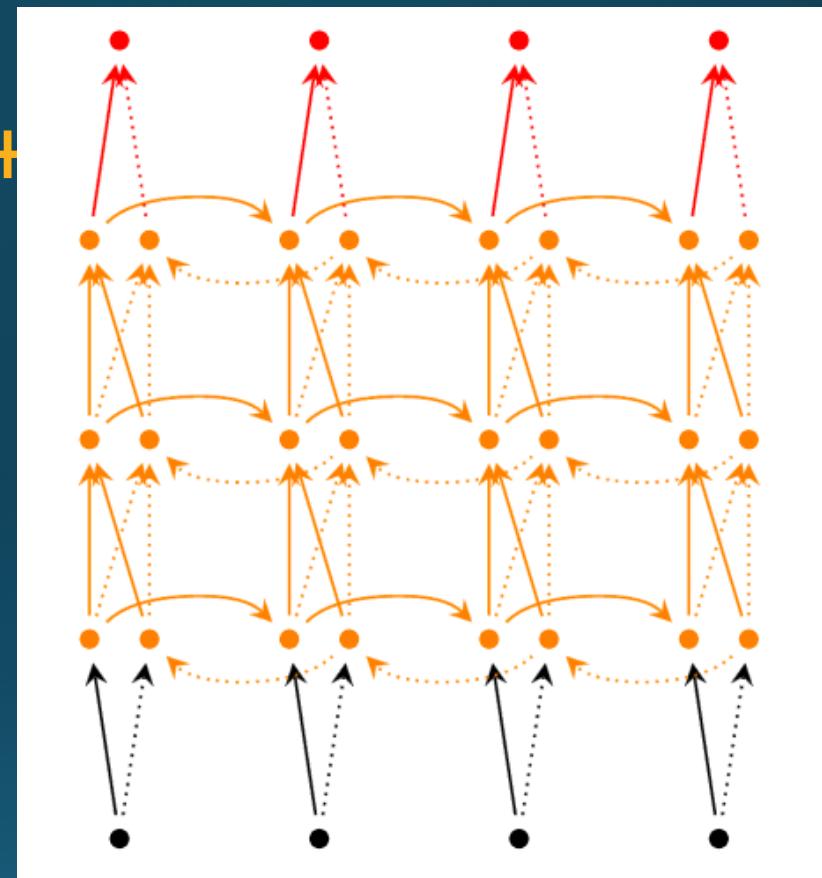


word embeddings

The proposal is criticized ...

Trend: RNNs + word embeddings

- Many powerful variations

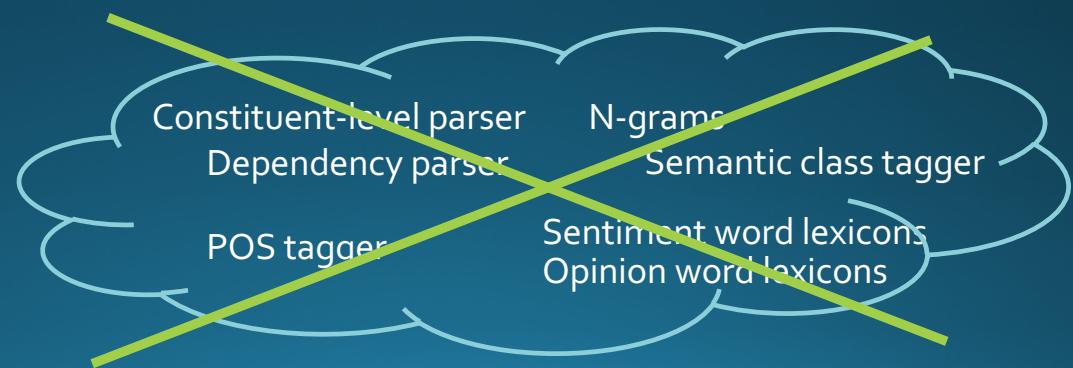


The proposal is criticized ...

word embeddings

Trend: RNNs + Word Embeddings

- Better or comparable performance than feature-based approaches
- Without NLP components, without feature engineering
 - Sentiment/opinion analysis: without manually procured sentiment lexicons



Opinion analysis

opinion expressions	proportional overlap	exact match
CRF	64.4 F	57.7 F
CRF + word embeddings	66.4 F	59.6 F
Deep bidirectional RNNs	71.7 F	66.0 F

[Irsoy & Cardie, EMNLP2014]

Opinion expressions

(1)

The situation obviously remains fluid from hour to hour but it seems to be going in the right direction
DEEPRNN The situation obviously remains fluid from hour to hour but it seems to be going in the right direction
SHALLOW The situation obviously remains fluid from hour to hour but it seems to be going in the right direction
SEMICRF The situation obviously remains fluid from hour to hour but it seems to be going in the right direction

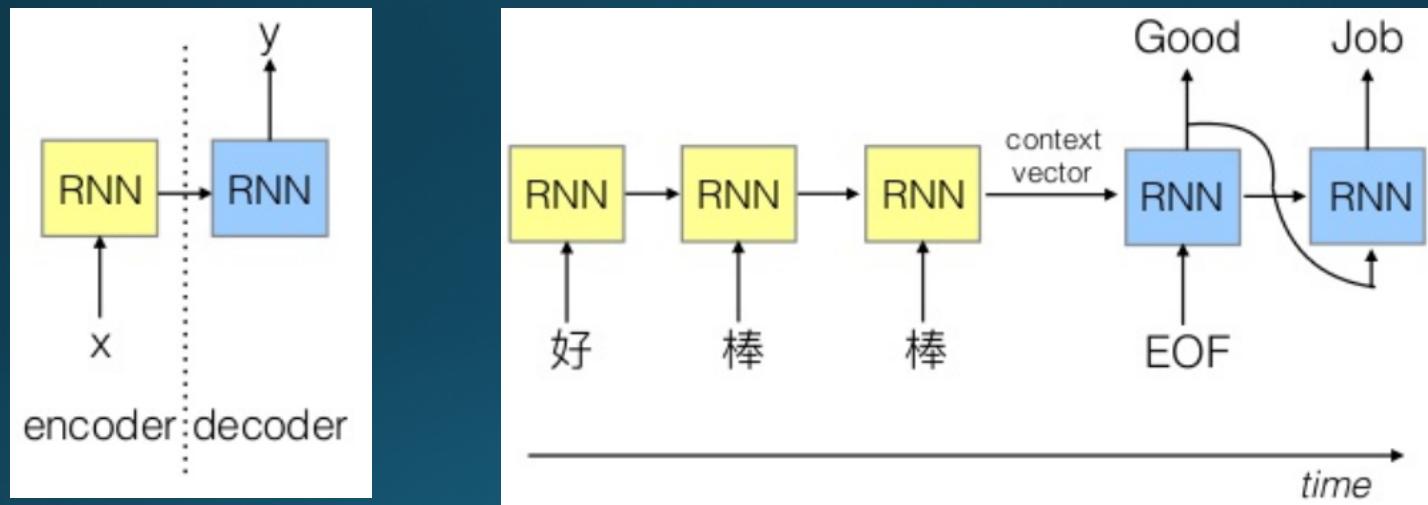
(2)

have always said this is a multi-faceted campaign but equally we have also said any future military action would have to be based on evidence , ...
DEEPRNN have always said this is a multi-faceted campaign but equally we have also said any future military action would have to be based on evidence , ...
SHALLOW have always said this is a multi-faceted campaign but equally we have also said any future military action would have to be based on evidence , ...
SEMICRF have always said this is a multi-faceted campaign but equally we have also said any future military action would have to be based on evidence , ...

Many many RNN variations

- Gated Recurrent Network (GRU) [Cho et al., EMNLP/CoRR2014; Chung et al., CoRR2014]
- Long Short-Term Memory [Hochreiter & Schmidhuber, *NeurComp*1997]
- Memory Networks [Weston et al., ICLR2015]
- Dynamic Memory Network (DRM) [Kumar et al., ICML2016]
- Dynamic-Context Generative Model [Sordoni et al., MAACL2015]
- ...

Sequence to sequence learning

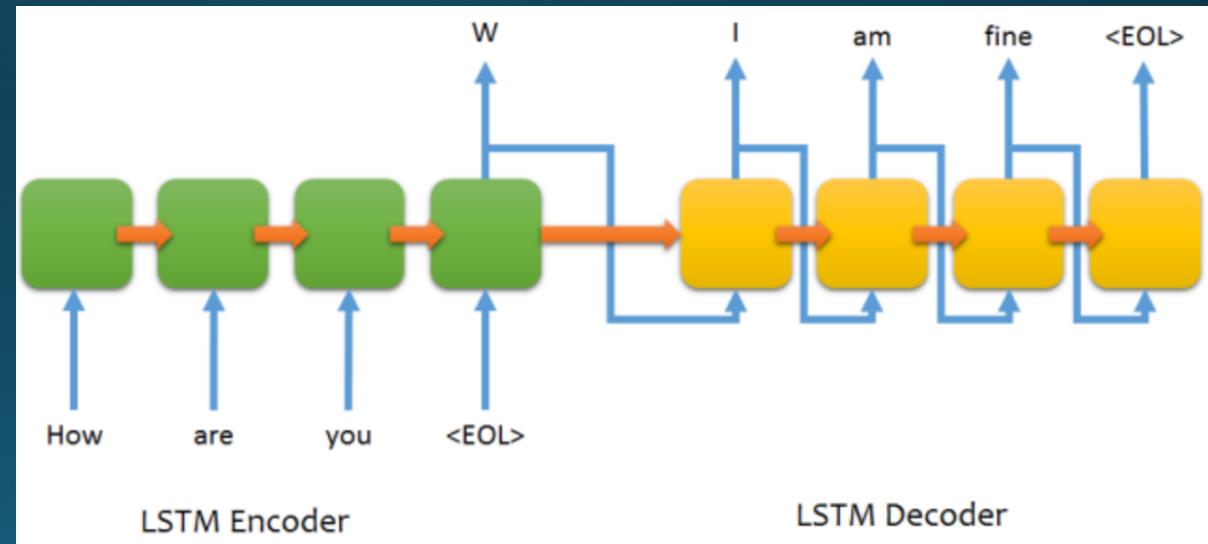


Outperforms phrase-based statistical MT system for English to French.
Close to state-of-the-art. No standard NLP preprocessing components.

Sutskever et al. (NIPS2014)

Sequence to sequence learning

- Many NLP applications
 - QA
 - POS tagging
 - Summarization
 - Chatbots



On the horizon: inferences

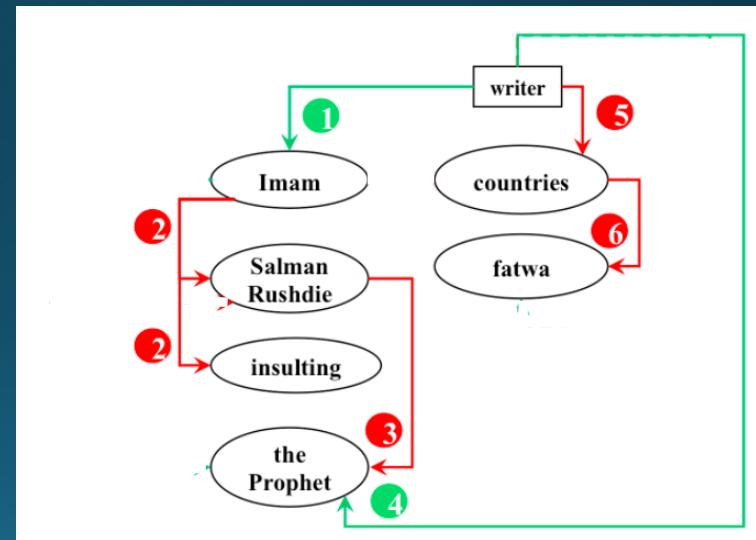
Most research in NLP aims to capture only the literal meaning of text. However, much of what we *communicate* is not stated explicitly but rather *inferred*.

Inferred opinions

When the Imam (may God be satisfied with him ¹) issued the fatwa against ² Salman Rushdie for insulting ³ the Prophet (peace be upon him ⁴), the countries that are so-called ⁵ supporters of human rights protested against ⁶ the fatwa.

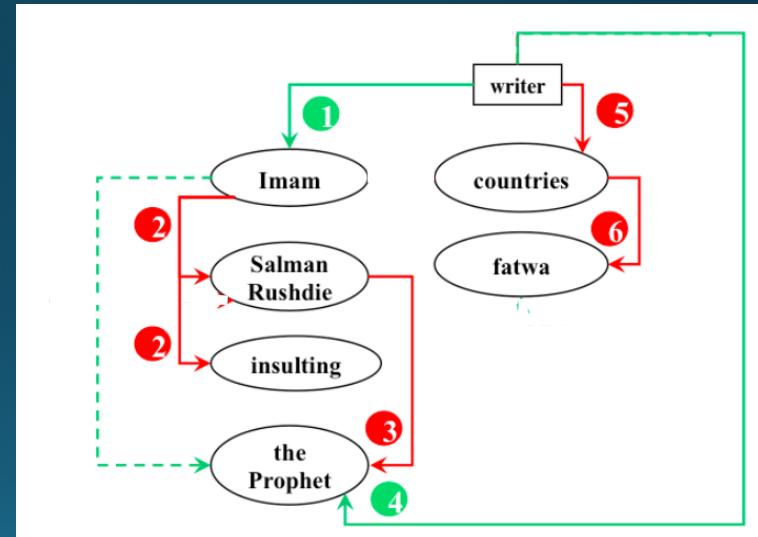
Inferred opinions

When the Imam (may God be satisfied with him **1**) issued the fatwa against **2** Salman Rushdie for insulting **3** the Prophet (peace be upon him **4**), the countries that are so-called **5** supporters of human rights protested against **6** the fatwa.



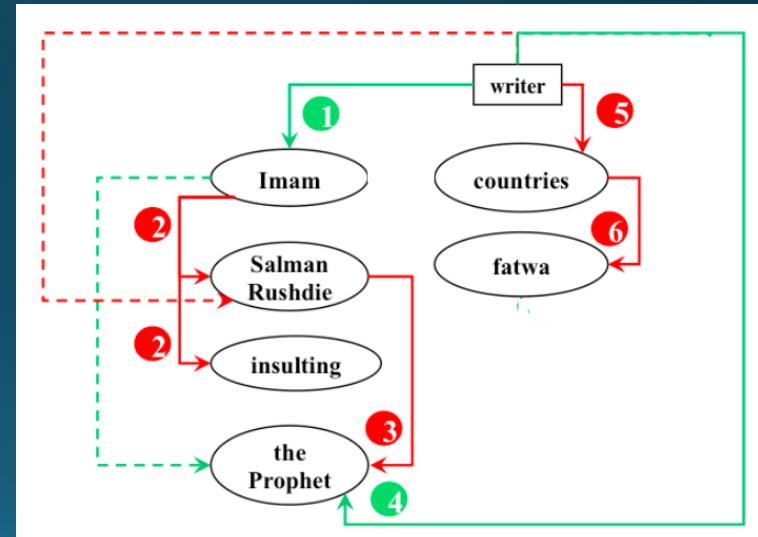
Inferred opinions

When the Imam (may God be satisfied with him **1**) issued the fatwa against **2** Salman Rushdie for insulting **3** the Prophet (peace be upon him **4**), the countries that are so-called **5** supporters of human rights protested against **6** the fatwa.



Inferred opinions

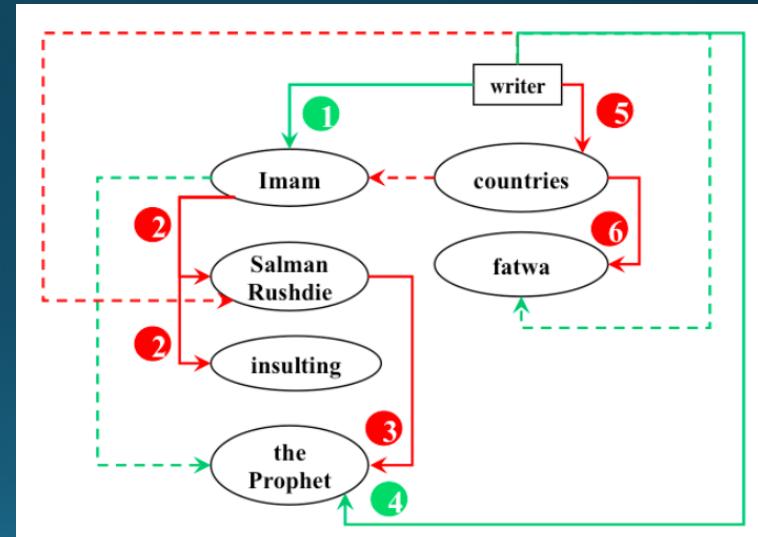
When the Imam (may God be satisfied with him **1**) issued the fatwa against **2** Salman Rushdie for insulting **3** the Prophet (peace be upon him **4**), the countries that are so-called **5** supporters of human rights protested against **6** the fatwa.



Inferred opinions

[Deng & Wiebe, EMNLP2015]
[Deng, PhD thesis, 2016]

When the Imam (may God be satisfied with him **1**) issued the fatwa against **2** Salman Rushdie for insulting **3** the Prophet (peace be upon him **4**), the countries that are so-called **5** supporters of human rights protested against **6** the fatwa.



On the horizon: inferences

[de Marneffe, PhD thesis, 2012]

- Discourse analysis more generally
 - Inferences based on the context = Pragmatics

On the horizon: inferences

[de Marneffe, PhD thesis, 2012]

- Interpretation of yes-no questions

Do you want to go to lunch? I had a very big breakfast.

Was the movie *wonderful*? It was worth seeing.

Are your kids *little*? I have a 10 year-old and a 7 year-old.

- Can we automatically learn from real texts what meanings people assign to these modifiers?

On the horizon: inferences

[de Marneffe, PhD thesis, 2012]

- Detecting **conflicting** statements
 - Pieces of text that are extremely unlikely to be considered true simultaneously
 - (a) John thinks that he is incompetent.
 - (b) His boss believes that John is not being given a chance.

On the horizon: inferences

[de Marneffe, PhD thesis, 2012]

- Detecting **conflicting** statements
 - Pieces of text that are extremely unlikely to be considered true simultaneously
- (a) Maitur Rehman, a 29-year-old Pakistani from Multan in Punjab, is reported to be the present amir of Jundullah...
- (b) Intelligence sources in the U.S. and Pakistan tell NBC News that Maitur Rehman is a low-level militant operating in South Waziristan.

On the horizon: discourse and dialogue

- Argument parsing

¹There should be a full ban of peanut products on all airlines,²because peanut allergy could have terrible effects.³Peanut reactions can be life threatening.⁴Restricting to certain flights is not enough,⁵as residue from previous flights can remain on the seats.⁶Recently we flew across the country⁷and I find left over peanuts in our seats!

On the horizon: discourse and dialogue

- Argument parsing

¹There should be a full ban of peanut products on all airlines,²because peanut allergy could have terrible effects.³Peanut reactions can be life threatening.⁴Restricting to certain flights is not enough,⁵as residue from previous flights can remain on the seats.⁶Recently we flew across the country⁷and I find left over peanuts in our seats!

Fact

On the horizon: discourse and dialogue

- Argument parsing

¹There should be a full ban of peanut products on all airlines, ²because peanut allergy could have terrible effects. ³Peanut reactions can be life threatening. ⁴Restricting to certain flights is not enough, ⁵as residue from previous flights can remain on the seats. ⁶Recently we flew across the country⁷and I find left over peanuts in our seats!

Testimony

On the horizon: discourse and dialogue

- Argument parsing

¹There should be a full ban of peanut products on all airlines,²because peanut allergy could have terrible effects.³Peanut reactions can be life threatening.⁴Restricting to certain flights is not enough,⁵as residue from previous flights can remain on the seats.⁶Recently we flew across the country⁷and I find left over peanuts in our seats!

Value

On the horizon: discourse and dialogue

- Argument parsing

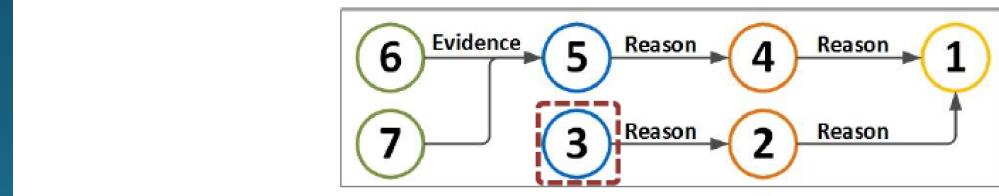
¹There should be a full ban of peanut products on all airlines,²because peanut allergy could have terrible effects.³Peanut reactions can be life threatening.⁴Restricting to certain flights is not enough,⁵as residue from previous flights can remain on the seats.⁶Recently we flew across the country⁷and I find left over peanuts in our seats!

Policy

On the horizon: discourse and dialogue

- Argument parsing

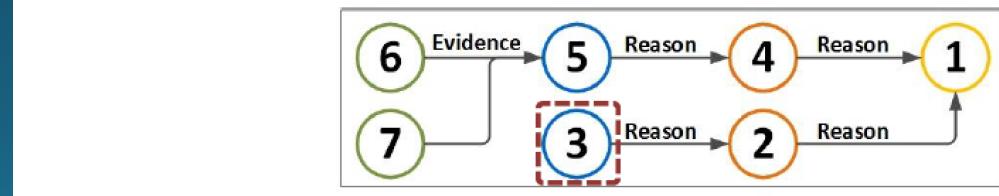
1There should be a full ban of peanut products on all airlines,**2**because peanut allergy could have terrible effects.**3**Peanut reactions can be life threatening.**4**Restricting to certain flights is not enough,**5**as residue from previous flights can remain on the seats.**6**Recently we flew across the country**7**and I find left over peanuts in our seats!



On the horizon: discourse and dialogue

- Argument parsing
and evaluation

1There should be a full ban of peanut products on all airlines,**2**because peanut allergy could have terrible effects.**3**Peanut reactions can be life threatening.**4**Restricting to certain flights is not enough,**5**as residue from previous flights can remain on the seats.**6**Recently we flew across the country**7**and I find left over peanuts in our seats!



On the horizon: discourse and dialogue

- Argument parsing
and evaluation

¹There should be a full ban of peanut products on all airlines,²because peanut allergy could have terrible effects.³Peanut reactions can be life threatening.⁴Restricting to certain flights is not enough,⁵as residue from previous flights can remain on the seats.⁶Recently we flew across the country⁷and I find left over peanuts in our seats!

(<http://www.peanuts.com/reactions>)

*Joonsuk Park
Vlad Niculae

1st and 2nd Argument Mining Workshops at ACL 2015, 2016

Conclusions

- Trends in NLP
 - Word embeddings
 - Return to recurrent neural nets
 - Sequence to sequence models
- On the horizon
 - Inferences
 - Arguments