Exploiting and Expanding Corpus Resources for Frame-Semantic Parsing

Nathan Schneider, CMU
(with Chris Dyer & Noah A. Smith)

April 26, 2013 ▪ IFNW'13

FrameNet + NLP = <3

- We want to develop systems that understand text
- Frame semantics and FrameNet offer a linguistically & computationally satisfying theory/representation for semantic relations

Roadmap

- A frame-semantic parser
- Multiword expressions
- Simplifying annotation for syntax + semantics

Frame-semantic parsing

SemEval Task 19 [Baker, Ellsworth, & Erk 2007]

Frame-semantic parsing

SemEval Task 19 [Baker, Ellsworth, & Erk 2007]

- Given a text sentence, analyze its frame semantics. Mark:

Frame-semantic parsing

SemEval Task 19 [Baker, Ellsworth, & Erk 2007]

- Given a text sentence, analyze its frame semantics. Mark:
    - words/phrases that are lexical units

Frame-semantic parsing

SemEval Task 19 [Baker, Ellsworth, & Erk 2007]

- Given a text sentence, analyze its frame semantics. Mark:
  - words/phrases that are lexical units
  - frame evoked by each LU

Frame-semantic parsing

SemEval Task 19 [Baker, Ellsworth, & Erk 2007]

- Given a text sentence, analyze its frame semantics. Mark:
  - words/phrases that are lexical units
  - frame evoked by each LU
  - frame elements (role–argument pairings)

Frame-semantic parsing

SemEval Task 19 [Baker, Ellsworth, & Erk 2007]

- Given a text sentence, analyze its frame semantics. Mark:
  - words/phrases that are lexical units
  - frame evoked by each LU
  - frame elements (role–argument pairings)
- Analysis is in terms of groups of tokens. No assumption that we know the syntax.

SEMAFOR

[Das, Schneider, Chen, & Smith 2010]

Robots in **popular** culture **are there** to **remind** us of the awesomeness of unbounded **human** **agency**

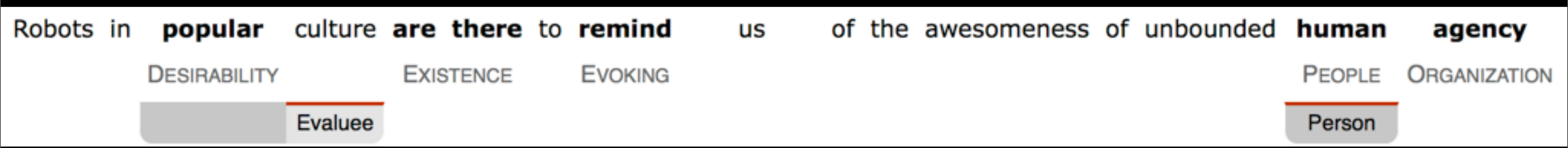
SEMAFOR

[Das, Schneider, Chen, & Smith 2010]

Robots	in	**popular**	culture	**are there**	to	**remind**	us	of	the	awesomeness	of	unbounded	**human**	**agency**
		DESIRABILITY		EXISTENCE		EVOKING							PEOPLE	ORGANIZATION

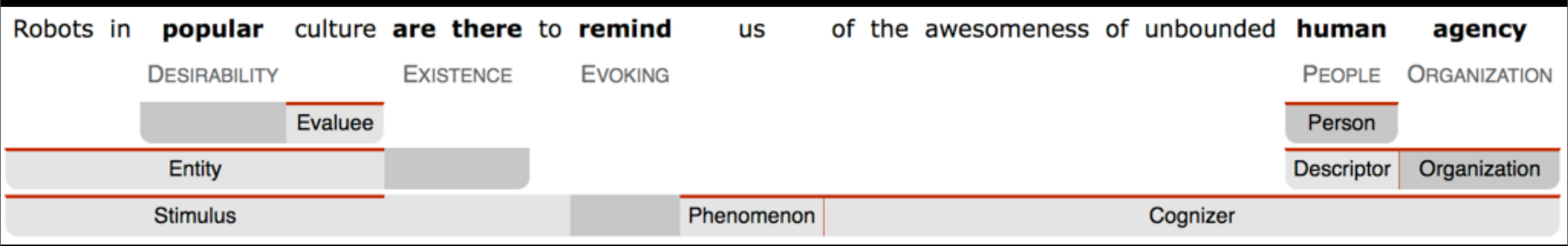
SEMAFOR

[Das, Schneider, Chen, & Smith 2010]



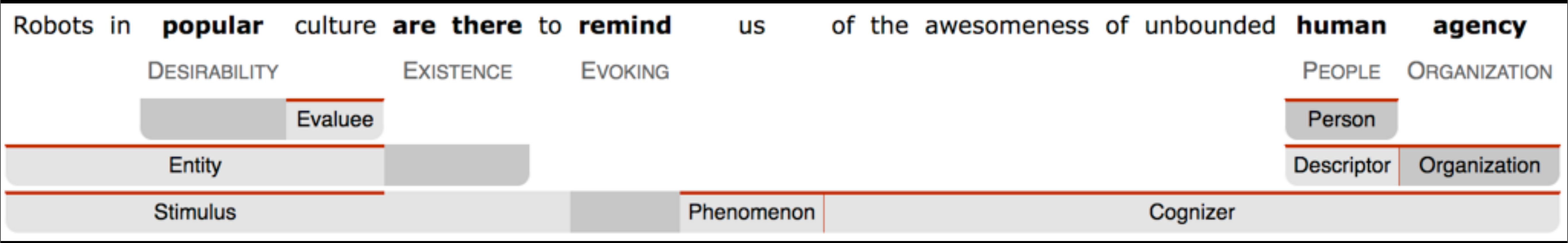
SEMAFOR

[Das, Schneider, Chen, & Smith 2010]



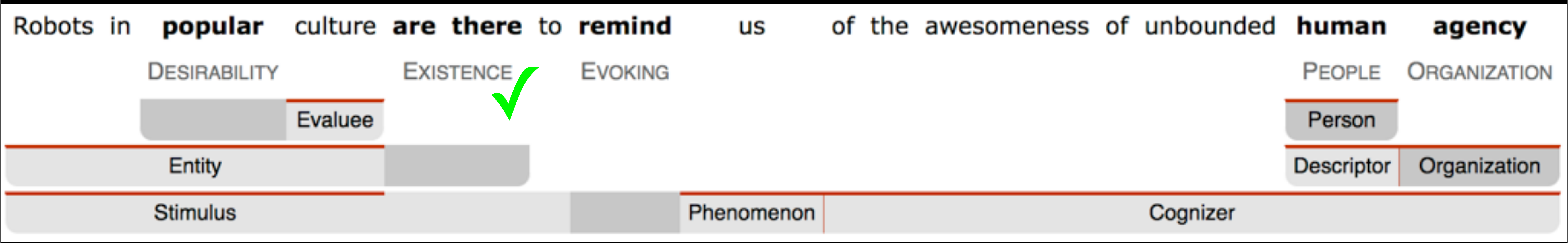
SEMAFOR

[Das, Schneider, Chen, & Smith 2010]



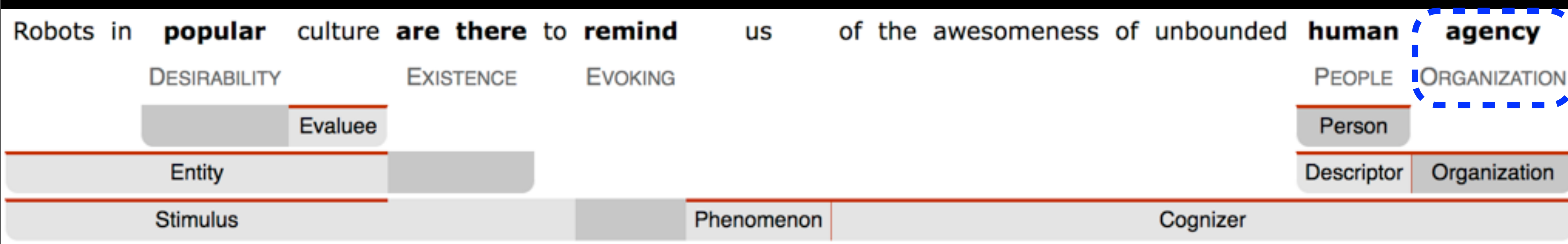
SEMAFOR

[Das, Schneider, Chen, & Smith 2010]



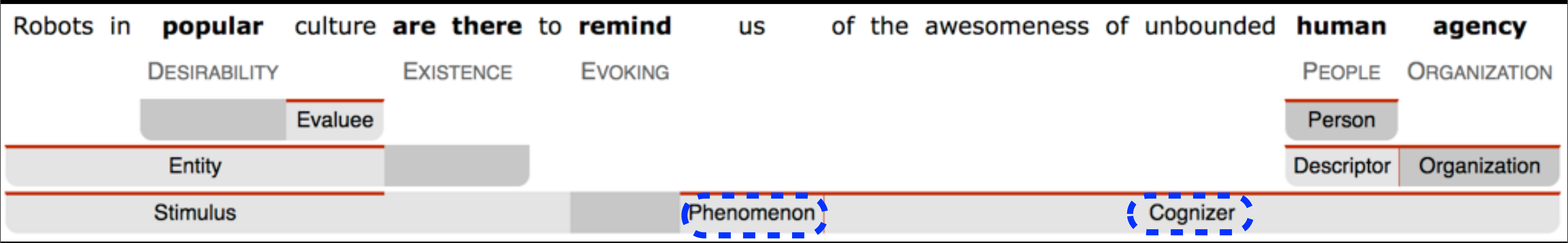
SEMAFOR

[Das, Schneider, Chen, & Smith 2010]



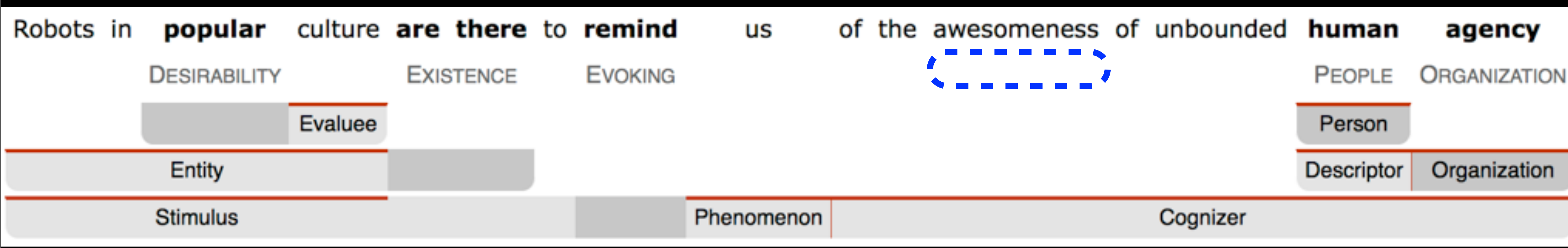
SEMAFOR

[Das, Schneider, Chen, & Smith 2010]



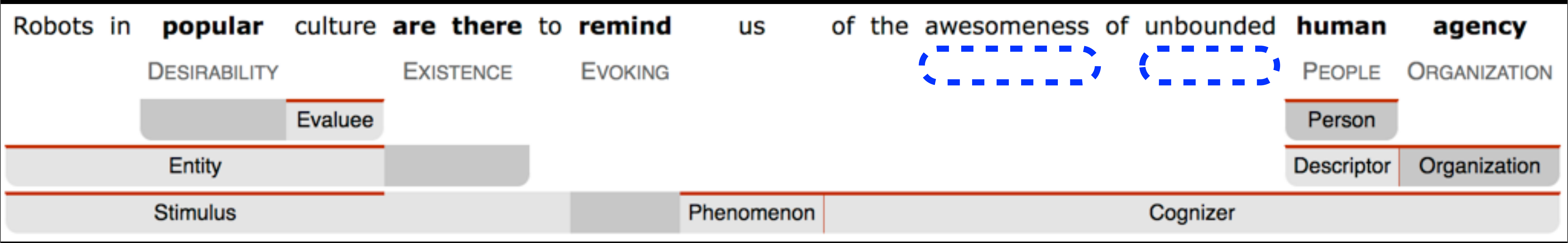
SEMAFOR

[Das, Schneider, Chen, & Smith 2010]



SEMAFOR

[Das, Schneider, Chen, & Smith 2010]



SEMAFOR

[Das, Schneider, Chen, & Smith 2010]

SEMAFOR

[Das, Schneider, Chen, & Smith 2010]

- SEMAFOR consists of a pipeline: preprocessing → target identification → frame identification → argument identification

SEMAFOR

[Das, Schneider, Chen, & Smith 2010]

- SEMAFOR consists of a pipeline: preprocessing → target identification → frame identification → argument identification
- Preprocessing: syntactic parsing

SEMAFOR

[Das, Schneider, Chen, & Smith 2010]

- SEMAFOR consists of a pipeline: preprocessing → target identification → frame identification → argument identification
- Preprocessing: syntactic parsing
- Heuristics + 2 statistical models

SEMAFOR

[Das, Schneider, Chen, & Smith 2010]

- SEMAFOR consists of a pipeline: preprocessing → target identification → frame identification → argument identification
- Preprocessing: syntactic parsing
- Heuristics + 2 statistical models
- Trained/tuned on English FrameNet's full-text annotations

Full-text Annotations

+ American National Corpus Texts

1. Berlitz History of Greece
2. Berlitz History of Jerusalem
3. Berlitz History of Las Vegas
4. Berlitz Intro of Dublin
5. Berlitz Intro of Hong Kong
6. Berlitz Intro of Jamaica
7. Berlitz What to Do in Hong Kong
8. Berlitz Where to Go in Hong Kong
9. Children's home fund-raising letter
10. Children's home fund-raising letter
11. Goodwill fund-raising letter
12. Goodwill fund-raising letter
13. Goodwill fund-raising letter
14. Goodwill fund-raising letter
15. Goodwill fund-raising letter
16. Goodwill fund-raising letter
17. journal_christine
18. journal_patrick
19. journal_ryan
20. journal.pbio.0020001
21. Slate magazine article: Entrepreneur as Madonna
22. Slate magazine article: Stephanopoulos Crimes

+ AQUAINT Knowledge-Based Evaluation Texts
+ LUCorpus-v0.3
+ Miscellaneous
+ Texts from Nuclear Threat Initiative website, created by Center for Non-Proliferation Studies
+ Wall Street Journal Texts from the PropBank Project

https://framenet.icsi.berkeley.edu/fndrupal/index.php?q=fulltextIndex

Full-text annotations

1. *Stephanopoulos* Analyzes *His* Own CRIME$_{\text{Committing_crime}}$

2. THERE$_{\text{Locative_relation}}$ *was* FORMER$_{\text{Time_vector}}$ *Clinton* aide *George Stephanopoulos* on *ABC* *'s* *This Week this morning* , furrow-browed *and* `` HEARTBROKEN$_{\text{Emotion\_directed}}$ *with all the* EVIDENCE$_{\text{Evidence}}$ coming *out* '' against *the* PRESIDENT$_{\text{Leadership}}$. Last WEEK$_{\text{Calendric\_unit}}$, WHEN$_{\text{Temporal\_collocation}}$ *the* *Lewinsky* story *was only* A$_{\text{Quantified\_mass}}$ FEW$_{\text{Quantified\_mass}}$ HOURS$_{\text{Measure\_duration}}$ OLD$_{\text{Age}}$, *Stephanopoulos* popped up on *Good Morning America* *to* demonstrate *his* CONCERN$_{\text{Emotion\_directed}}$. `` *These are* PROBABLY$_{\text{Likelihood}}$ *the* most SERIOUS$_{\text{Importance}}$ ALLEGATIONS$_{\text{Statement}}$ yet leveled against *the* PRESIDENT$_{\text{Leadership}}$. THERE$_{\text{Existence}}$ 'S$_{\text{Existence}}$ *no* QUESTION$_{\text{Point_of_dispute}}$ *that , if they 're* true , *they ... could* LEAD$_{\text{Causation}}$ *to* impeachment proceedings . ''

SEMAFOR

[Das, Schneider, Chen, & Smith 2010]

SEMAFOR

[Das, Schneider, Chen, & Smith 2010]

- SEMAFOR's models consist of features over observable parts of the sentence (words, lemmas, POS tags, dependency edges & paths) that may be predictive of frame/role labels

SEMAFOR

[Das, Schneider, Chen, & Smith 2010]

- SEMAFOR's models consist of features over observable parts of the sentence (words, lemmas, POS tags, dependency edges & paths) that may be predictive of frame/role labels
- Full-text annotations as training data for (semi)supervised learning

SEMAFOR

[Das, Schneider, Chen, & Smith 2010]

- SEMAFOR's models consist of features over observable parts of the sentence (words, lemmas, POS tags, dependency edges & paths) that may be predictive of frame/role labels
- Full-text annotations as training data for (semi)supervised learning
- Extensive body of work on semantic role labeling [starting with Gildea & Jurafsky 2002 for FrameNet; also much work for PropBank]

SEMAFOR

[Das, Schneider, Chen, & Smith 2010]

[Das et al. 2013 to appear]

SEMAFOR

[Das, Schneider, Chen, & Smith 2010]

- State-of-the-art performance on SemEval'07 evaluation (outperforms the best system from the task, Johansson & Nugues 2007)

[Das et al. 2013 to appear]

SEMAFOR

[Das, Schneider, Chen, & Smith 2010]

- State-of-the-art performance on SemEval'07 evaluation (outperforms the best system from the task, Johansson & Nugues 2007)
- On SE07: [F] 74% [A] 68% [F→A] 46%
  On FN1.5: [F] 91% [A] 80% [F→A] 69%

[Das et al. 2013 to appear]

SEMAFOR

[Das, Schneider, Chen, & Smith 2010]

- State-of-the-art performance on SemEval'07 evaluation (outperforms the best system from the task, Johansson & Nugues 2007)
- On SE07: [F] 74% [A] 68% [F→A] 46%
  On FN1.5: [F] 91% [A] 80% [F→A] 69%
  [Das et al. 2013 to appear]
- BUT: This task is really hard. Room for improvement at all stages.

SEMAFOR Demo

http://demo.ark.cs.cmu.edu/parse

How to improve?

- Better modeling with current resources?
- Ways to use non-FrameNet resources?
- Create new resources?

How to improve?

- Better modeling with current resources?
- Ways to use non-FrameNet resources?
- Create new resources?

Dipanjan Das

Sam Thomson

Better Modeling?

- We already have over a million features.
- better use of syntactic parsers (e.g., better argument span heuristics, considering alternative parses, constituent parsers)
- recall-oriented learning? [Mohit et al. 2012 for NER]
- better search in decoding [Das, Martins, & Smith 2012]
- joint frame ID & argument ID?

Use Other Resources?

- FN1.5 has just 3k sentences/20k targets in full-text annotations. data sparseness
- semisupervised learning: reasoning about unseen predicates with distributional similarity [Das & Smith 2011]
- NER? supersense tagging?
- use PropBank → FrameNet mappings to get more training data?

Roadmap

- A frame-semantic parser
- Multiword expressions
- Simplifying annotation for syntax + semantics

Roadmap

- A frame-semantic parser
- Multiword expressions
- Simplifying annotation for syntax + semantics

new resources

Roadmap

- A frame-semantic parser
- Multiword expressions
- Simplifying annotation for syntax + semantics

new resources

Multiword Expressions

Christmas Day.n

German measles.n

along with.prep

also_known_as.a

armed forces.n

bear arms.v

beat up.v

double-check.v

Losing_it:

lose it.v

go ballistic.v

flip out.v

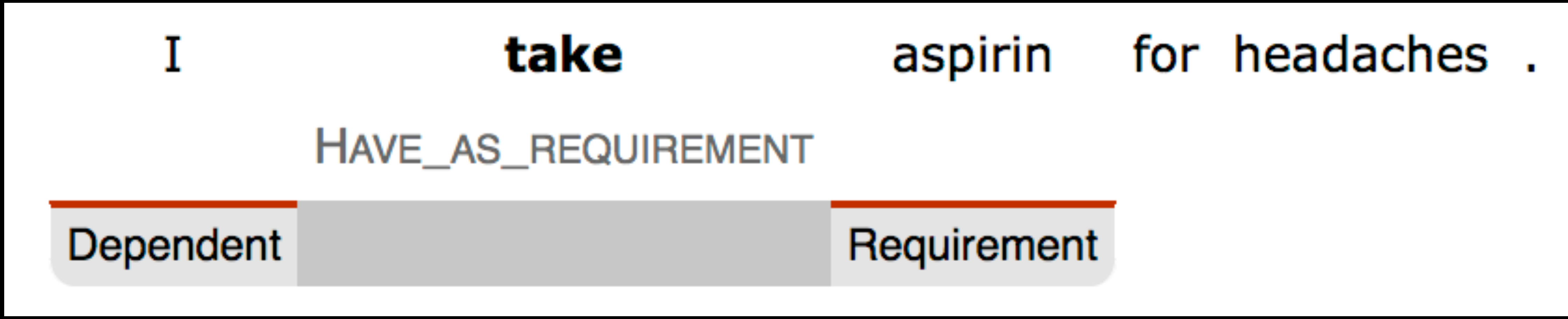
blow cool.v

freak out.v

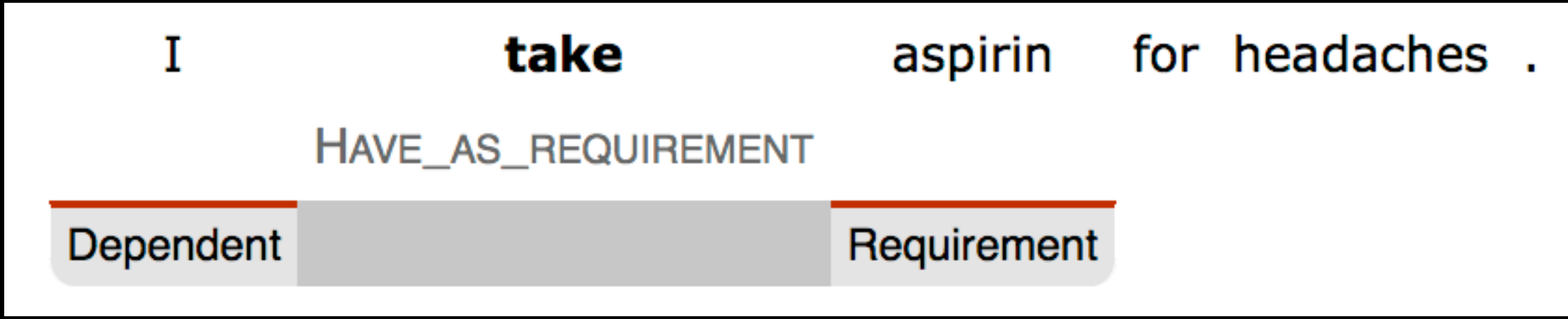
Multiword Expressions

- 926 unique multiword LUs in FrameNet lexicon
  - 545 w/ space, 222 w/ underscore, 177 w/ hyphen
  - 361 frames have an LU containing a space, underscore, or hyphen
- support constructions like ‘take a walk’: only the N should be frame-evoking [Calzolari et al. 2002]


I took an aspirin .
CONQUERING
Conqueror
Theme


I take aspirin for headaches .
HAVE_AS_REQUIREMENT
Dependent
Requirement


I took an aspirin .
CONQUERING
Conqueror
Theme

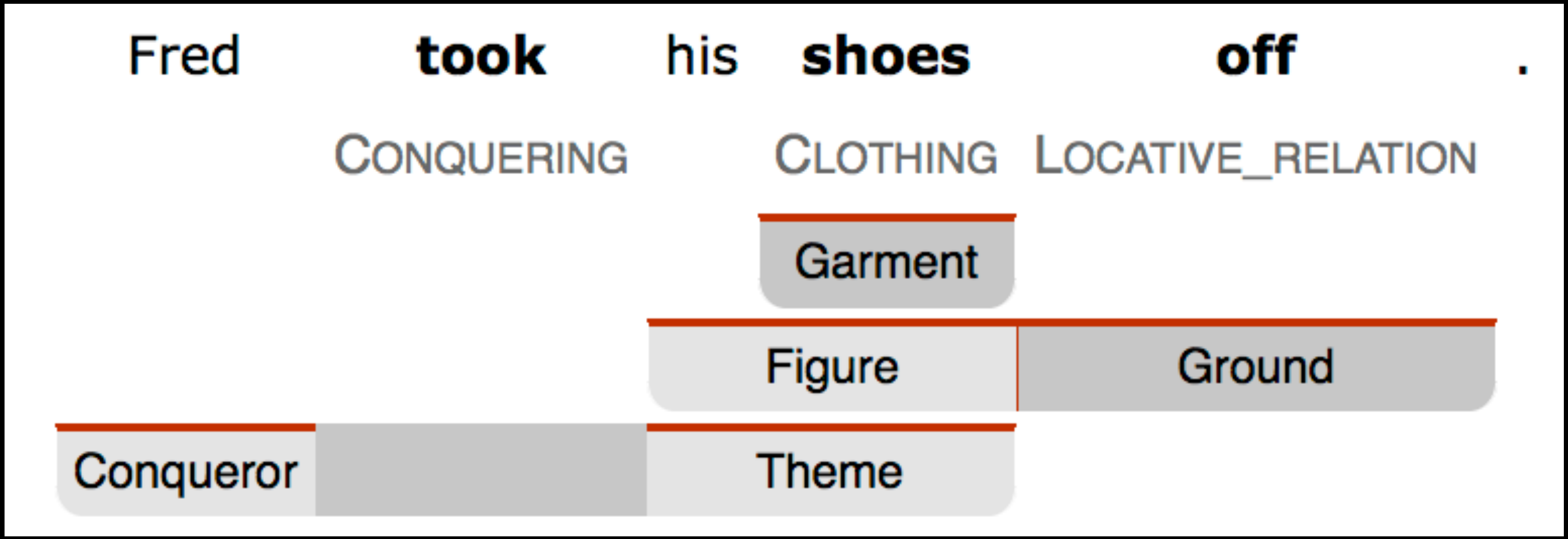

I take aspirin for headaches .
HAVE_AS_REQUIREMENT
Dependent
Requirement


Fred took off his shoes .
UNDRESSING
CLOTHING
Garment

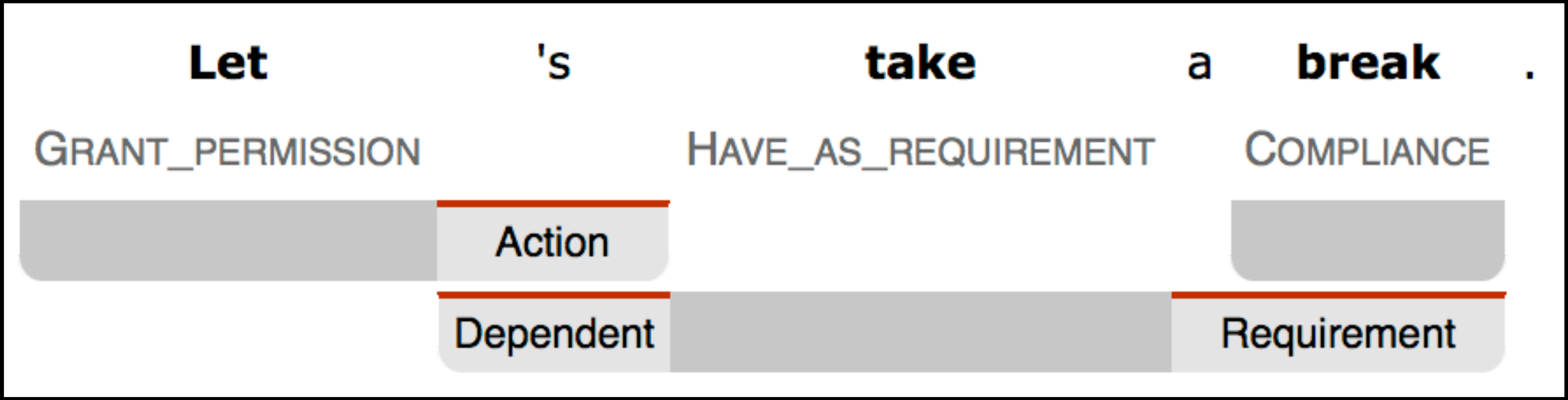

Fred took off his shoes .
UNDRESSING
CLOTHING
Garment


Fred took off his shoes .
UNDRESSING
CLOTHING
Garment

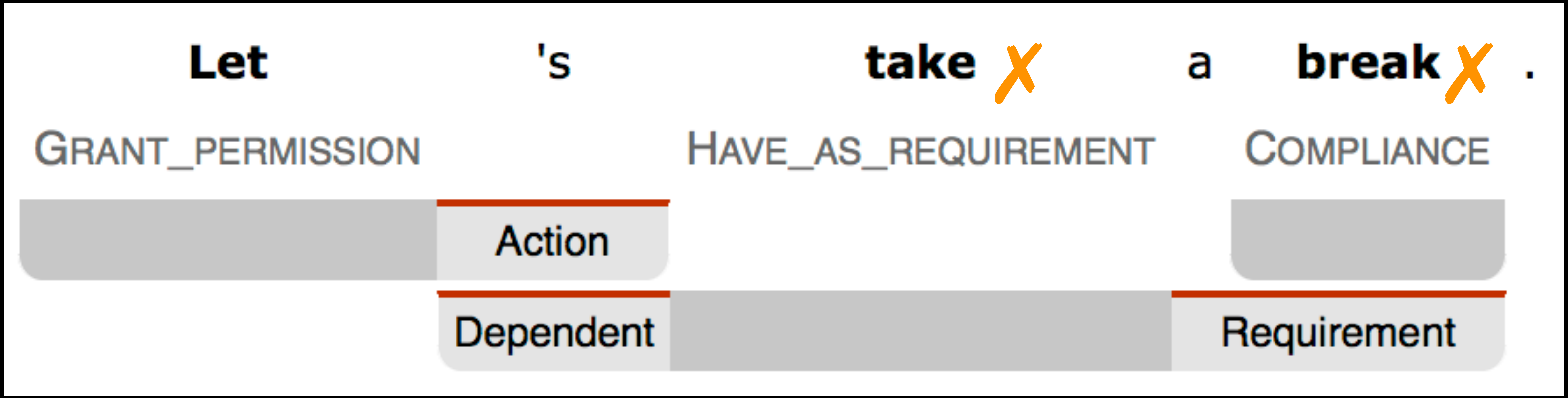
✓


Fred took his shoes off .
CONQUERING
CLOTHING
LOCATIVE_RELATION
Garment
Figure
Ground
Conqueror
Theme

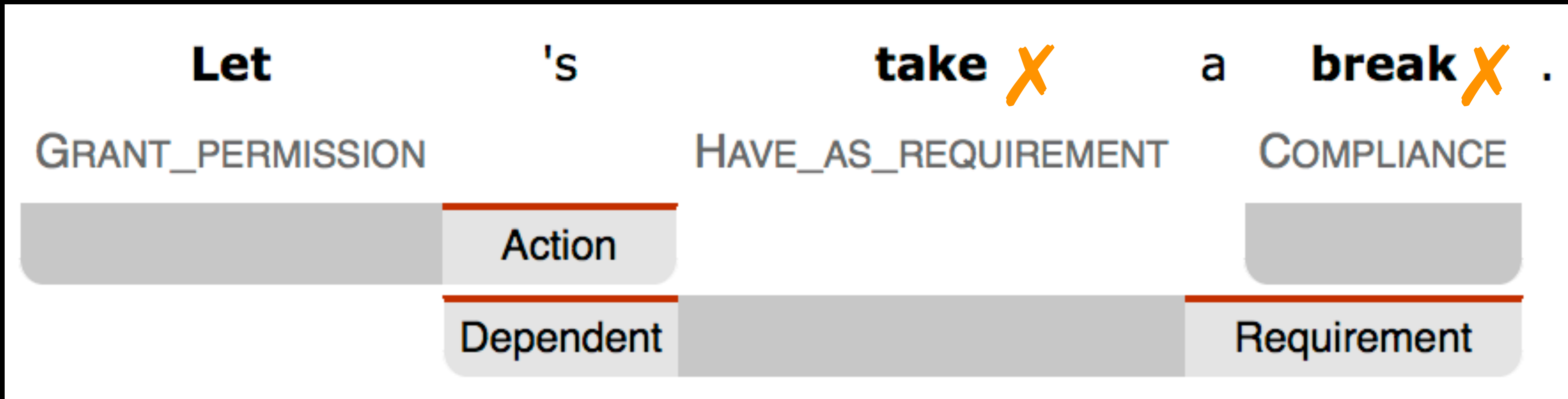
✗



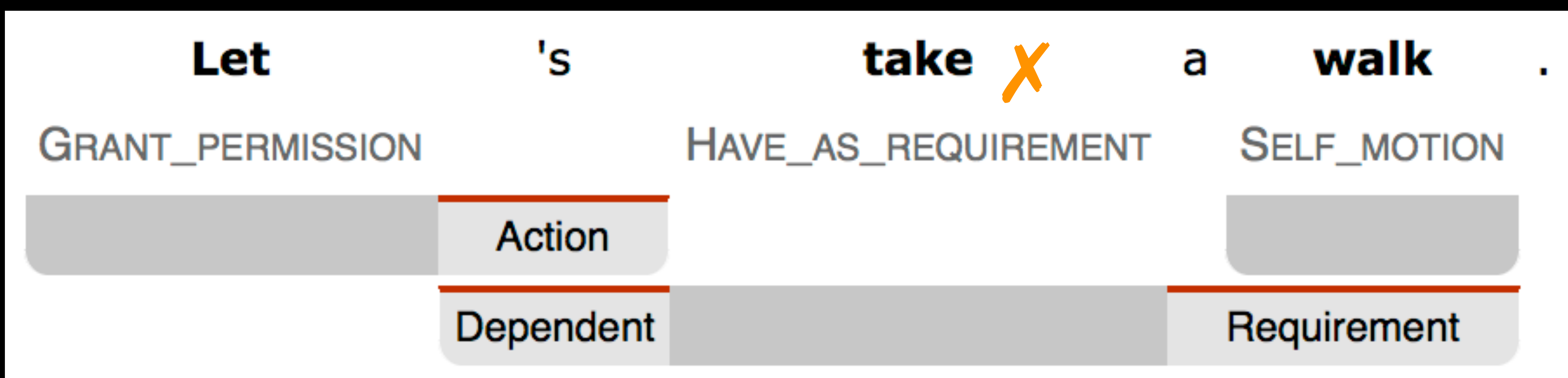
...even though take break.v is listed as an LU!
(probably not in training data)



...even though take break.v is listed as an LU!
(probably not in training data)



...even though take break.v is listed as an LU!
(probably not in training data)



- There has been a lot of work on specific kinds of MWEs (e.g. noun-noun compounds, phrasal verbs) [Baldwin & Kim, 2010]

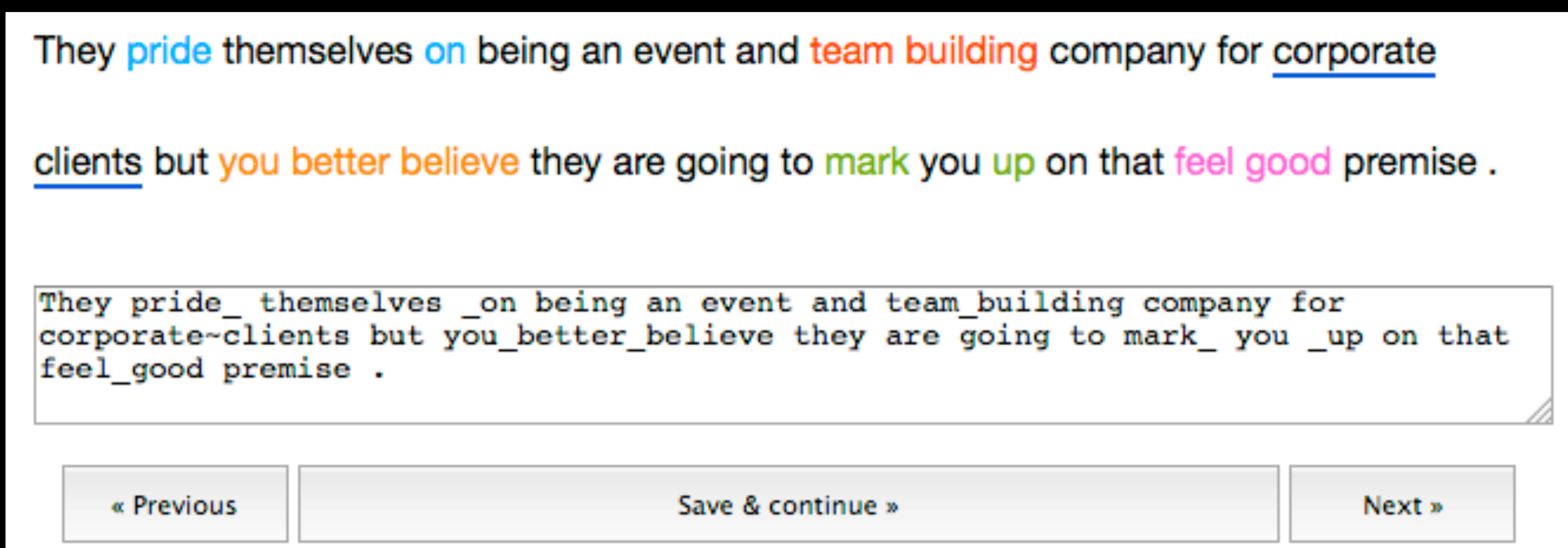
- There has been a lot of work on specific kinds of MWEs (e.g. noun-noun compounds, phrasal verbs) [Baldwin & Kim, 2010]
    - Special datasets, tasks, tools

- There has been a lot of work on specific kinds of MWEs (e.g. noun-noun compounds, phrasal verbs) [Baldwin & Kim, 2010]
    - Special datasets, tasks, tools
- Can MWE identification be formulated in an open-ended annotate-and-model fashion?

- There has been a lot of work on specific kinds of MWEs (e.g. noun-noun compounds, phrasal verbs) [Baldwin & Kim, 2010]
    - Special datasets, tasks, tools
- Can MWE identification be formulated in an open-ended annotate-and-model fashion?
    - Linguistic challenge: understanding and guiding **annotators' intuitions**

MWE Annotation

- We are annotating the 50k-word Reviews portion of the English Web Treebank with multiword units (MWEs + NEs)



MWE Annotation

It is right on the hustle and bustle of Wisconsin Ave but some might miss it as it is nestled in between Subway Sandwiches and Modell 's .

```
It is right on the hustle_and_bustle of Wisconsin_Ave but some might miss it as
it is nestled in_between Subway_Sandwiches and Modell_'s .
```

« Previous | Save & continue » | Next »

Examples

- My wife had taken her '07 Ford Fusion in for a routine oil change .
- The education is horrible at best , do society a favor , and do NOT send your student here .
- He called the next day to see if everything was to my satisfaction .
- After they showed up there was a little trouble to get my car unlocked , it took quite a bit of time but the job was well done .

MWE Annotation

- Eventual goal: train a system to detect multiword lexical items (including discontiguous ones)
- Replace or supplement SEMAFOR's target identification phase

Roadmap

- A frame-semantic parser
- Multiword expressions
- Simplifying annotation for syntax + semantics

new resources

Lightweight Syntax + Semantics

- My wife had taken her '07 Ford Fusion in for a routine oil change .

```
My > wife > had < [taken in] < [’07 Ford Fusion] < her

[taken in] < for < [oil change]

a > [oil change] < routine
```

Lightweight Syntax + Semantics

- My wife had taken her '07 Ford Fusion in for a routine oil change .

```
My > wife > had < [taken in] < [’07 Ford Fusion] < her

[taken in] < for < [oil change]

a > [oil change] < routine

            wife :: Personal_relationship
      [taken in] :: Bringing
[’07 Ford Fusion] :: Vehicle/NE
         routine :: Typicality?
    [oil change] :: ?
```

Lightweight Syntax + Semantics

- My wife had taken her '07 Ford Fusion in for a routine oil change .

```
My > wife > had < taken < [’07 Ford Fusion] < her

in > taken < for < [oil change]

a > [oil change] < routine

             wife :: Personal_relationship
       taken < in :: Bringing
[’07 Ford Fusion] :: Vehicle/NE
          routine :: Typicality?
     [oil change] :: ?
```

Full-text Annotations

1. *Stephanopoulos* Analyzes *His* Own CRIME$_{\text{Committing_crime}}$

2. THERE$_{\text{Locative_relation}}$ *was* FORMER$_{\text{Time_vector}}$ *Clinton* aide *George Stephanopoulos* on *ABC* *'s* *This Week this morning* , furrow-browed *and* `` HEARTBROKEN$_{\text{Emotion\_directed}}$ *with all the* EVIDENCE$_{\text{Evidence}}$ coming *out* '' against *the* PRESIDENT$_{\text{Leadership}}$. Last WEEK$_{\text{Calendric\_unit}}$, WHEN$_{\text{Temporal\_collocation}}$ *the* *Lewinsky* story *was only* A$_{\text{Quantified\_mass}}$ FEW$_{\text{Quantified\_mass}}$ HOURS$_{\text{Measure\_duration}}$ OLD$_{\text{Age}}$, *Stephanopoulos* popped up on *Good Morning America* *to* demonstrate *his* CONCERN$_{\text{Emotion\_directed}}$. `` *These are* PROBABLY$_{\text{Likelihood}}$ *the* most SERIOUS$_{\text{Importance}}$ ALLEGATIONS$_{\text{Statement}}$ yet leveled against *the* PRESIDENT$_{\text{Leadership}}$. THERE$_{\text{Existence}}$ 'S$_{\text{Existence}}$ *no* QUESTION$_{\text{Point_of_dispute}}$ *that , if they* *'re* true , *they ... could* LEAD$_{\text{Causation}}$ *to* impeachment proceedings . ''

Amateur Frame Annotation

Stephanopoulos:NE Analyzes:Scrutiny His Own Crime:Committing_crime

Amateur Frame Annotation

Stephanopoulos:NE Analyzes:Scrutiny* His Own Crime:Committing_crime

Amateur Frame Annotation

Amateur Frame Annotation

There_was:Existence*Locative_relation former:Time_vector Clinton:NE aide:Subordinates_and_superiors* George_Stephanopoulos:NE on ABC:NE 's This_Week:NE this morning:Calendric_unit* , furrow–browed:Observable_body_parts* and ` ` heartbroken:Emotion_directed with all the evidence:Evidence coming_out:?* '' against the president:People_by_vocation*Leadership .

Amateur Frame Annotation

There_was:Existence*Locative_relation former:Time_vector Clinton:NE aide:Subordinates_and_superiors* George_Stephanopoulos:NE on ABC:NE 's This_Week:NE this morning:Calendric_unit* , furrow–browed:Observable_body_parts* and ` ` heartbroken:Emotion_directed with all the evidence:Evidence coming_out:?* '' against the president:People_by_vocation*Leadership .

- Is an ‘aide’ someone who is Assisting, or someone who is the object of Employing, or one of Subordinates_and_superiors (like ‘assistant’)?

Amateur Frame Annotation

There_was:Existence*Locative_relation former:Time_vector Clinton:NE aide:Subordinates_and_superiors* George_Stephanopoulos:NE on ABC:NE 's This_Week:NE this morning:Calendric_unit* , furrow–browed:Observable_body_parts* and `` heartbroken:Emotion_directed with all the evidence:Evidence coming_out:?* '' against the president:People_by_vocation*Leadership .

- Is an ‘aide’ someone who is Assisting, or someone who is the object of Employing, or one of Subordinates_and_superiors (like ‘assistant’)?
- ‘coming out’: is that Reveal_secret, or does that frame imply the speaker is revealing his own secrets? Evidence again?

Amateur Frame Annotation

There_was:Existence*Locative_relation former:Time_vector Clinton:NE aide:Subordinates_and_superiors* George_Stephanopoulos:NE on ABC:NE 's This_Week:NE this morning:Calendric_unit* , furrow–browed:Observable_body_parts* and ` ` heartbroken:Emotion_directed with all the evidence:Evidence coming_out:?* '' against the president:People_by_vocation*Leadership .

- Is an ‘aide’ someone who is Assisting, or someone who is the object of Employing, or one of Subordinates_and_superiors (like ‘assistant’)?
- ‘coming out’: is that Reveal_secret, or does that frame imply the speaker is revealing his own secrets? Evidence again?
- ‘president’: Leadership? or People_by_vocation?

Amateur Frame Annotation

Last week:Calendric_unit , when the Lewinsky:NE story:Text* was only a few:*Quantified_mass hours:*Measure_duration old:Age , Stephanopoulos:NE popped_up:Arrive* on Good_Morning_America:NE to demonstrate:Cause_to_perceive* his concern:Emotion_directed .

- want a Journalism frame for ‘story’
- want Make_appearance for ‘pop up’

Amateur Frame Annotation

Amateur Frame Annotation

- Is this feasible?

Amateur Frame Annotation

- Is this feasible?
- Challenges: lexicon coverage (LUs & frames); large number of frames; deciding which frame is most appropriate when there are multiple facets of meaning

Amateur Frame Annotation

- Is this feasible?
- Challenges: lexicon coverage (LUs & frames); large number of frames; deciding which frame is most appropriate when there are multiple facets of meaning
- Many open issues in how to structure the annotation: e.g., Should annotators proceed token-by-token, predicate-by-predicate, or frame-by-frame? [cf. Kilgarriff 1998, Garrette & Baldridge 2013]

Summary

Summary

- The SEMAFOR system is state-of-the-art for frame-semantic parsing

Summary

- The SEMAFOR system is state-of-the-art for frame-semantic parsing
- …but not as good as we'd like

Summary

- The SEMAFOR system is state-of-the-art for frame-semantic parsing
- ...but not as good as we'd like
- Many errors can be attributed to preprocessing

Summary

- The SEMAFOR system is state-of-the-art for frame-semantic parsing
- …but not as good as we'd like
- Many errors can be attributed to preprocessing
- Others likely due to data sparseness

Summary

- The SEMAFOR system is state-of-the-art for frame-semantic parsing
- ...but not as good as we'd like
- Many errors can be attributed to preprocessing
- Others likely due to data sparseness
    - We are exploring relatively cheap forms of semantic annotation that should be useful

Summary

- The SEMAFOR system is state-of-the-art for frame-semantic parsing
- ...but not as good as we'd like
- Many errors can be attributed to preprocessing
- Others likely due to data sparseness
    - We are exploring relatively cheap forms of semantic annotation that should be useful
- Thanks for listening & discussion!