Frame-Semantic Parsing

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May 31, 2015 ▪ FrameNet Tutorial at NAACL-HLT

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

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.

FrameNet SRL, Parsing: Early Work

- The original SRL paper actually used FrameNet (Gildea & Jurafsky 2002).
  Also Thompson et al. 2003 (w/ frame ID), Fleischman et al. 2003, Padó & Lapata 2005, Erk & Padó 2006, Matsubayashi et al. 2009, Fürstenau & Lapata 2009.

- SemEval 2007 shared task (Baker et al. 2007): full-text annotations.
  Best system by Johansson & Nugues.

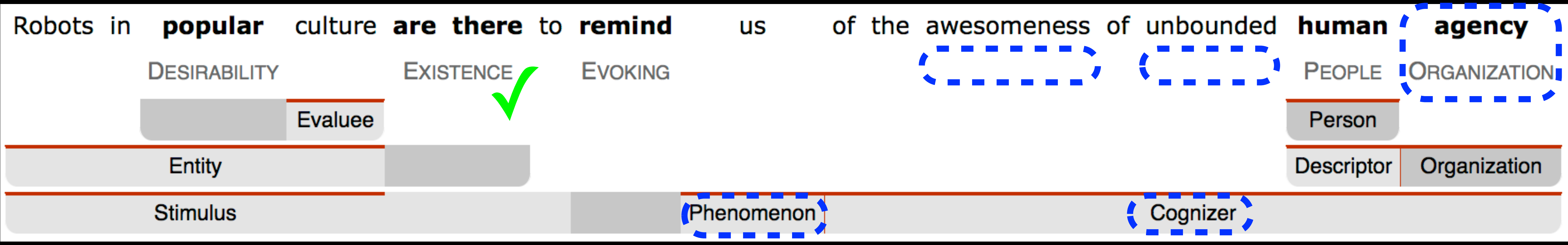
SEMAFOR

[Das, Schneider, Chen, & Smith 2010]

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

SEMAFOR

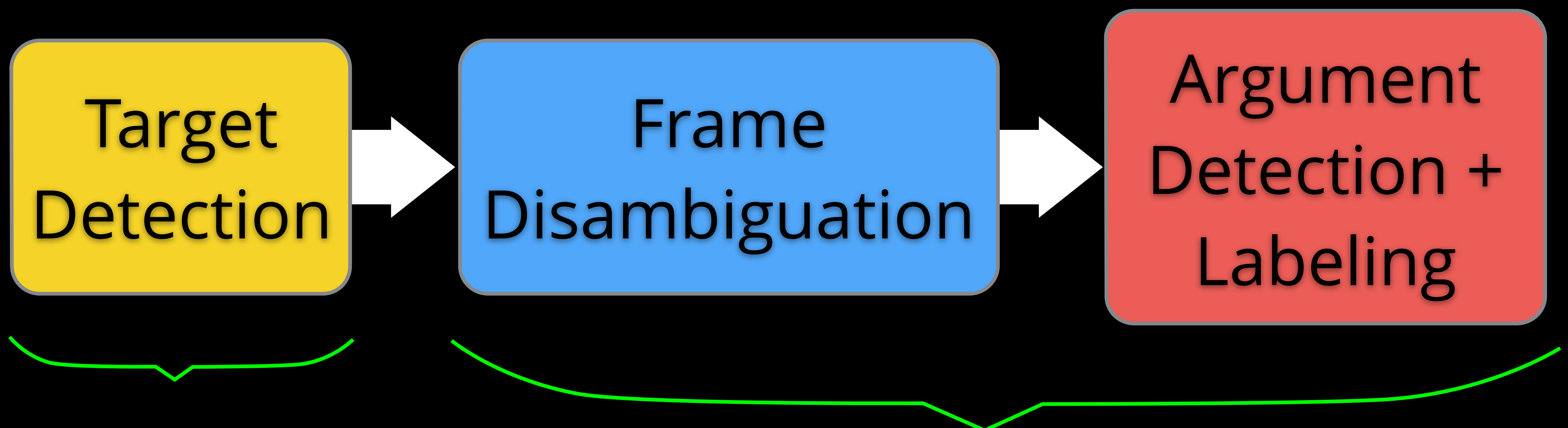
[Das, Schneider, Chen, & Smith 2010]



The SEMAFOR Pipeline

[Das, Schneider, Chen, & Smith 2010]

Preprocessing: syntactic dependency parser



heuristic
(whitelist)

statistical
(supervised, feature-based)
trained on 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'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]

- 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. 2014]
- BUT: This task is really hard. Room for improvement at all stages.

SEMAFOR Demo

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

So Amelia Bedelia sat right down

and she drew those drapes.

How to improve?

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

Karl Moritz Hermann

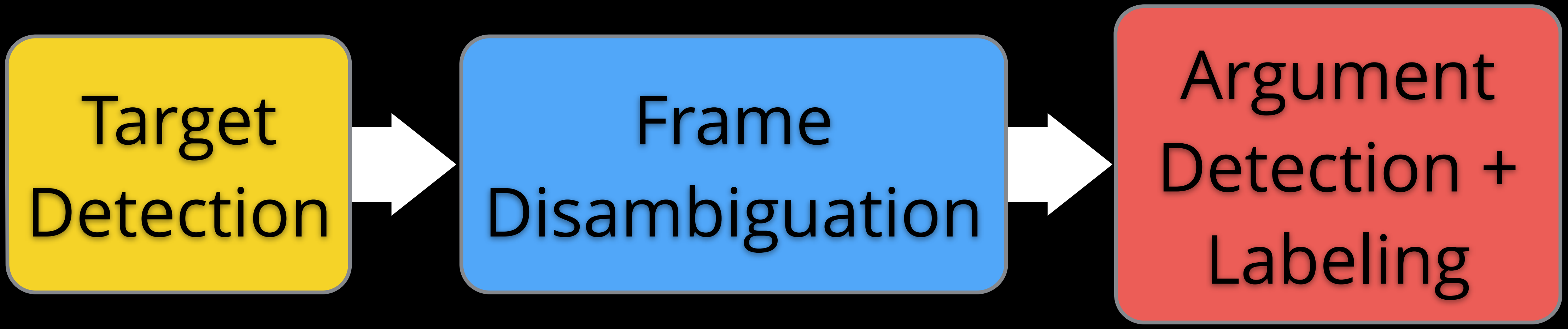
Oscar Täckström

Dipanjan Das

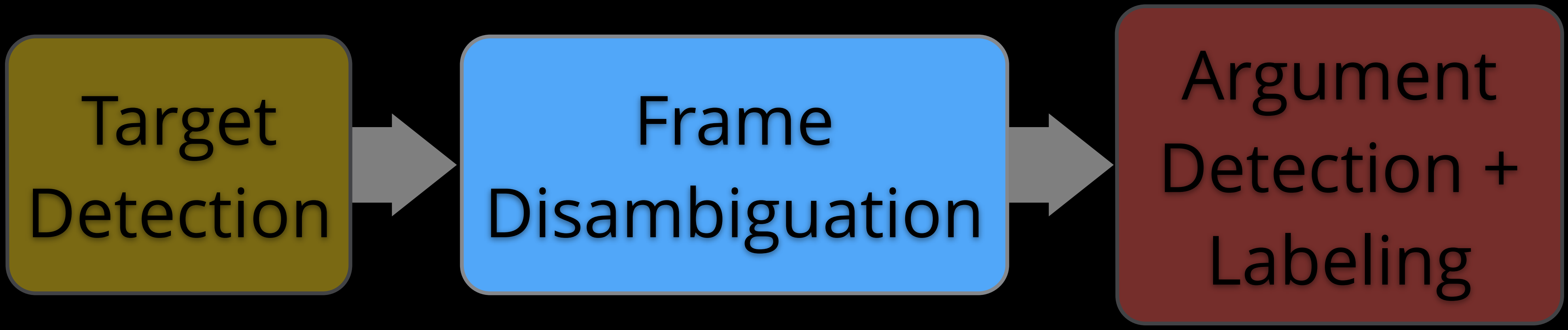
Sam Thomson

Meghana Kshirsagar

Advances in Modeling



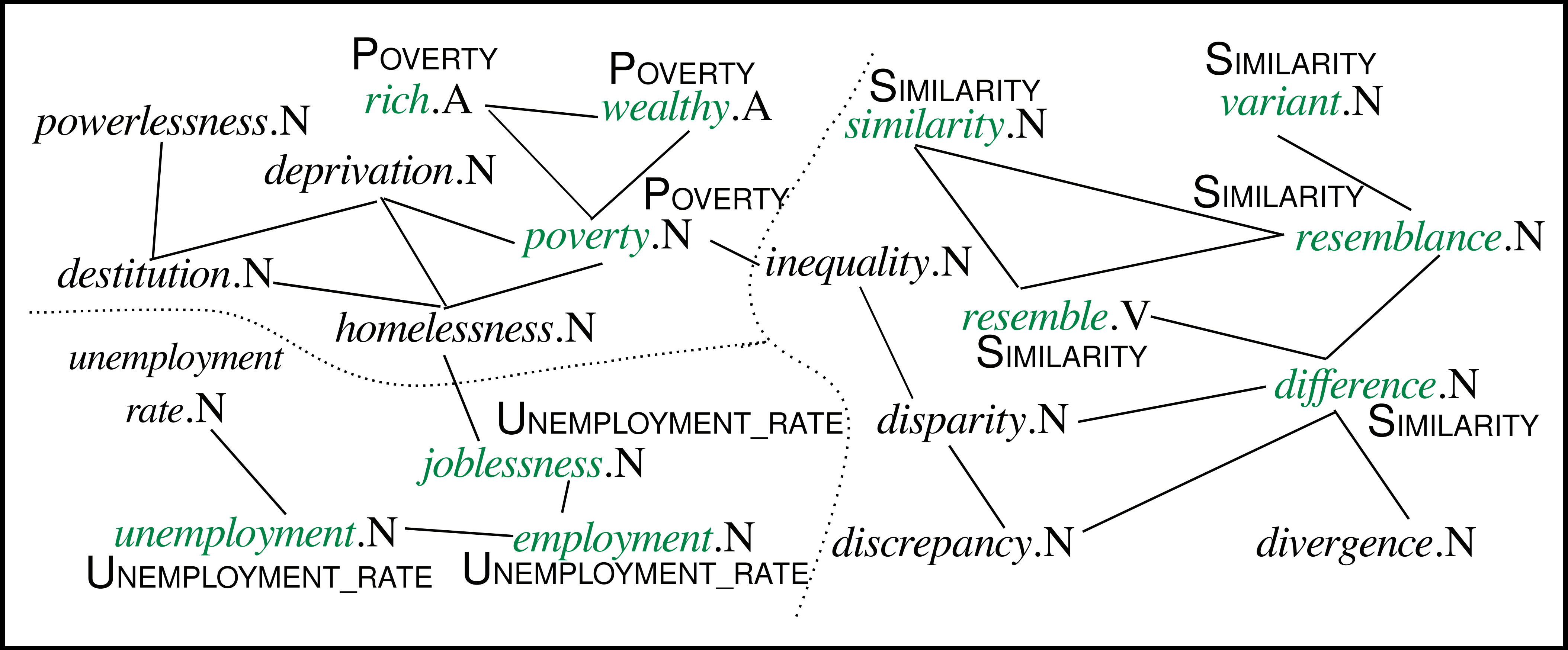
Advances in Modeling



Unknown Predicates

- **Problem:** Many frame-evoking predicates are seen neither in lexicon nor training data. How, then, to assign the correct frame?
- **Solution:** Propagate frame labels from known predicates to unknown predicates in a similarity graph. [Das & Smith 2011, 2012 / 2014]

Unknown Predicates



Word Representations

- **Problem:** With little training data, many features are too infrequent to be useful—particularly for rare/unseen words.
- **Solution:** Learn word embeddings that are predictive of frame labels (neural network).
[Hermann et al. 2014]

Advances in Modeling

Constraints on Argument Combinations

- **Problem:** A frame's arguments should not overlap, but this means classification decisions are not independent.
  - Also, some frames define hard Requires/Excludes constraints over role pairs.
- **Solution 1:** Beam search (approximate).
  [Das et al. 2010 / 2014]
- **Solution 2:** Dual decomposition (exact).
  [Das et al. 2012 / 2014]
- **Solution 3** (Google's variant of SEMAFOR)**:** Label arguments with dynamic programming. [Täckström et al. 2015]

Constraints on Argument Combinations

Conclusion

- SEMAFOR system from CMU has been applied to tasks as diverse as stock prediction and spoken dialogue segmentation

  http://www.ark.cs.cmu.edu/SEMAFOR/

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

- Ongoing research at CMU, Google, & elsewhere!

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