

CONNOTATIONWORDNET: LEARNING CONNOTATION OVER THE WORD+SENSE NETWORK



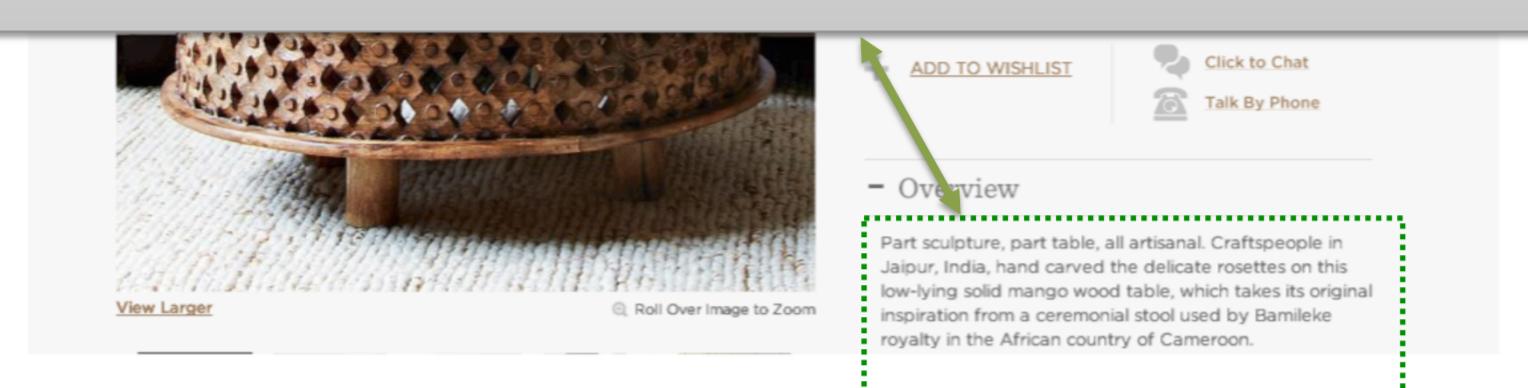
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Motivation

Part *sculpture*, part table, all *artisanal*. *Craftpeople* in Jaipur, India, hand carved the delicate *rosettes* on this low-lying solid *mango wood* table, which takes its original inspiration from a *ceremonial* stool used by Bamileke *royalty* in the African country of Cameroon.



- Overall tone is **positive**
- WITHOUT traditional & explicit sentiment words
- Highlighted words creates the positive tone.

Connotation

- Commonly understood cultural or emotional association that some word carries, in addition to its explicit or literal meaning(denotation)
- Generally described as **positive** or **negative**

WordNet Search - 3.1

- WordNet home page - Glossary - Help
List of senses
Display Options... (Select option to change) [+] Change
Key: "S" - Show current semantic relations "M" - Show multiple sense
Display sense: a set of synonyms
Noun
→ S. (n) **intension** connotation what you must know in reference of an expression
→ S. (n) connotation (an idea that is implied or suggested)

"science"

- (n) science, scientific discipline
a particular branch of scientific knowledge "the science of genetics"
- (n) skill, science
ability to produce solutions in some problem domain

"abound"

- (v) abound
be abundant or plentiful; exist in large quantities
- (v) abound, burst, bristle
be in a state of movement or action
"The room abounded with screaming children"; "The garden bristled with toddlers"

→ Different connotative polarities at sense-level

→ Different connotative polarities at sense-level

→ Subjectivity & Objectivity at sense-level

(Pestian, 2012; Mihalcea, 2012; Balahur, 2014)

- Found to be useful to further improve the sentiment analysis

→ Word Sense Disambiguation

- Sense-level resources
- Sometimes too noisy to integrate
- Word-level label aggregation over senses
– Loss of granularity

Finer Granularity
→ Learn both word & sense-level connotations

Related Work

Sentiment Lexicons

- Word-level
 - Wiebe et al., 2005; Qiu et al., 2009; Wilson et al., 2005; Kamps et al., 2004; Takamura et al., 2005; Andreevskaia and Bergler, 2006; Su and Markert 2009; Lu et al., 2011; Kaji and Kit-suregawa, 2007 ...
- Sense-level
 - SentiWordNet (Baccianella et al., 2010)

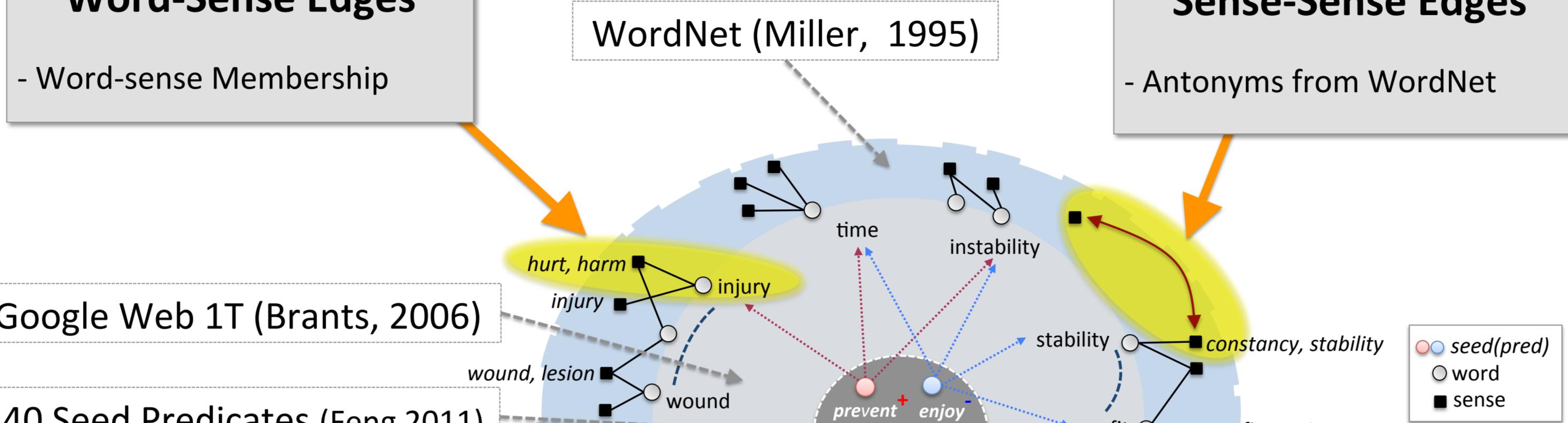
Connotation Lexicons

- Word-level
 - Connotation Lexicon(Feng, 2011/2013)
- Sense-level
 - This Work!

Graph Construction

Word-Sense Edges

Word-sense Membership



Sense-Sense Edges

Antonyms from WordNet

Seed(Pred)-Word

Connotative Predicates

"A predicate that has *selectional preference* on the connotative polarity of some of its semantic arguments." (Feng, 2011)

Selectional Preference

- enjoy^{pred} swimming^{word}
- prevent^{pred} leakage^{pred}

Word-Word Edges

Semantic Parallelism of Coordination

- pattern: [word] and [word]
ex) college and party

- Distributional Similarity
- cosine similarity

Inference Algorithm

Markov Random Field

Maximize:

$$P(y|x) = \frac{1}{Z(x)} \prod_{Y_i \in \mathcal{Y}} \psi_i(y_i) \prod_{e(Y_i, Y_j) \in E} \psi_{ij}(y_i, y_j)$$

Node labels as random variables: {+, -}

edge types:
 pred → word
 word → word
 word → sense
 sense → sense

compatibility potentials

Loopy Belief Propagation

Approximate inference algorithm *linearly scalable* with network size (Pearl, 1982)

- Iteratively talk to neighbors, passing **messages**
- Computes **belief** when reached to the consensus



"I believe you are in these states with these likelihoods."

Compatibility Potentials

Message

$$m_{i \rightarrow j}(y_j) = \alpha \sum_{y_i \in \mathcal{L}} (\psi_{ij}^t(y_i, y_j) \psi_i(y_i)) \prod_{Y_k \in \mathcal{N}_i \setminus \{Y_j\}} m_{k \rightarrow i}(y_k), \forall y_j \in \mathcal{L}$$

prior potentials

compatibility potentials

Belief

$$b_i(y_i) = \beta \psi_i(y_i) \prod_{Y_j \in \mathcal{N}_i} m_{j \rightarrow i}(y_i), \forall y_i \in \mathcal{L}$$

pred-word

word-word

word-sense

sense-sense

Quantifies the compatibility of the labels of nodes connected by edges

Edges are heterogeneous

Different potentials for each type

pred-word

word-word

word-sense

sense-sense

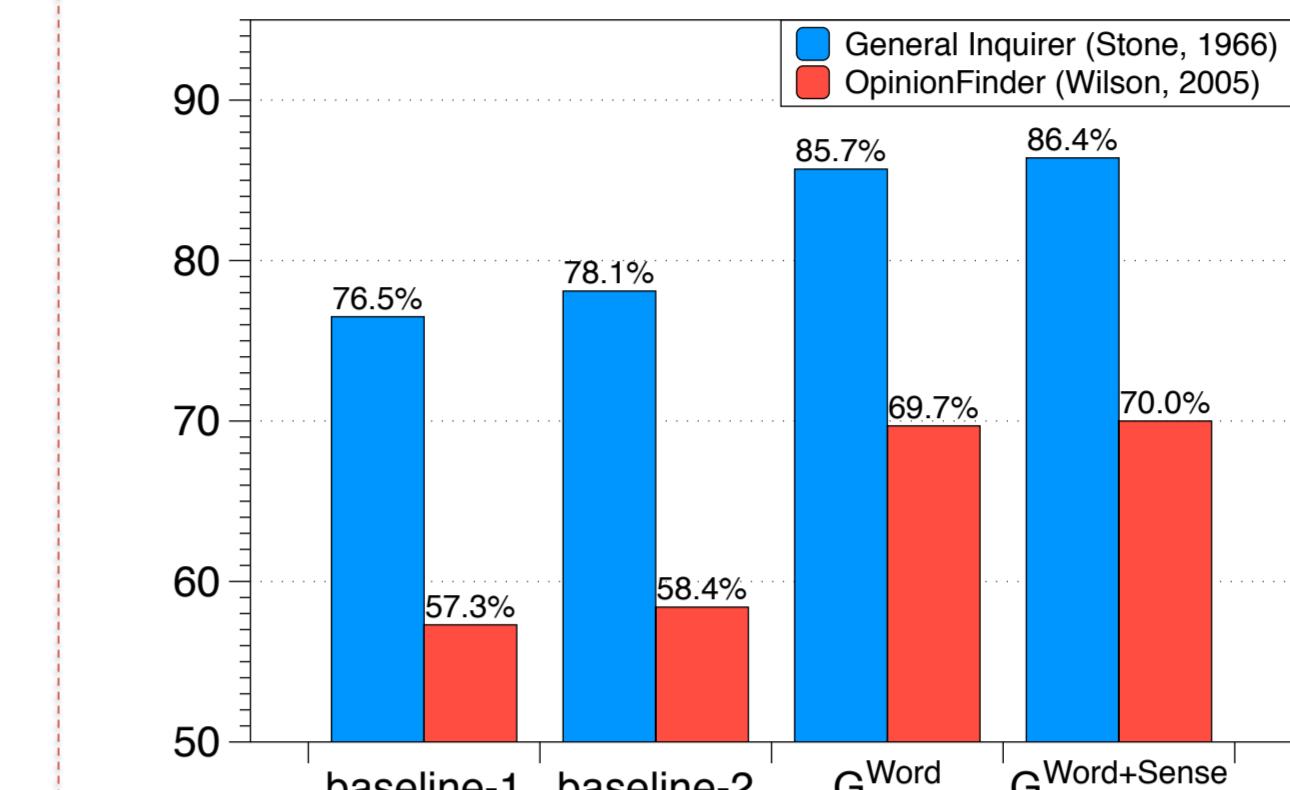
* $\epsilon = 0.1$

synonyms (word-sense membership)

antonyms

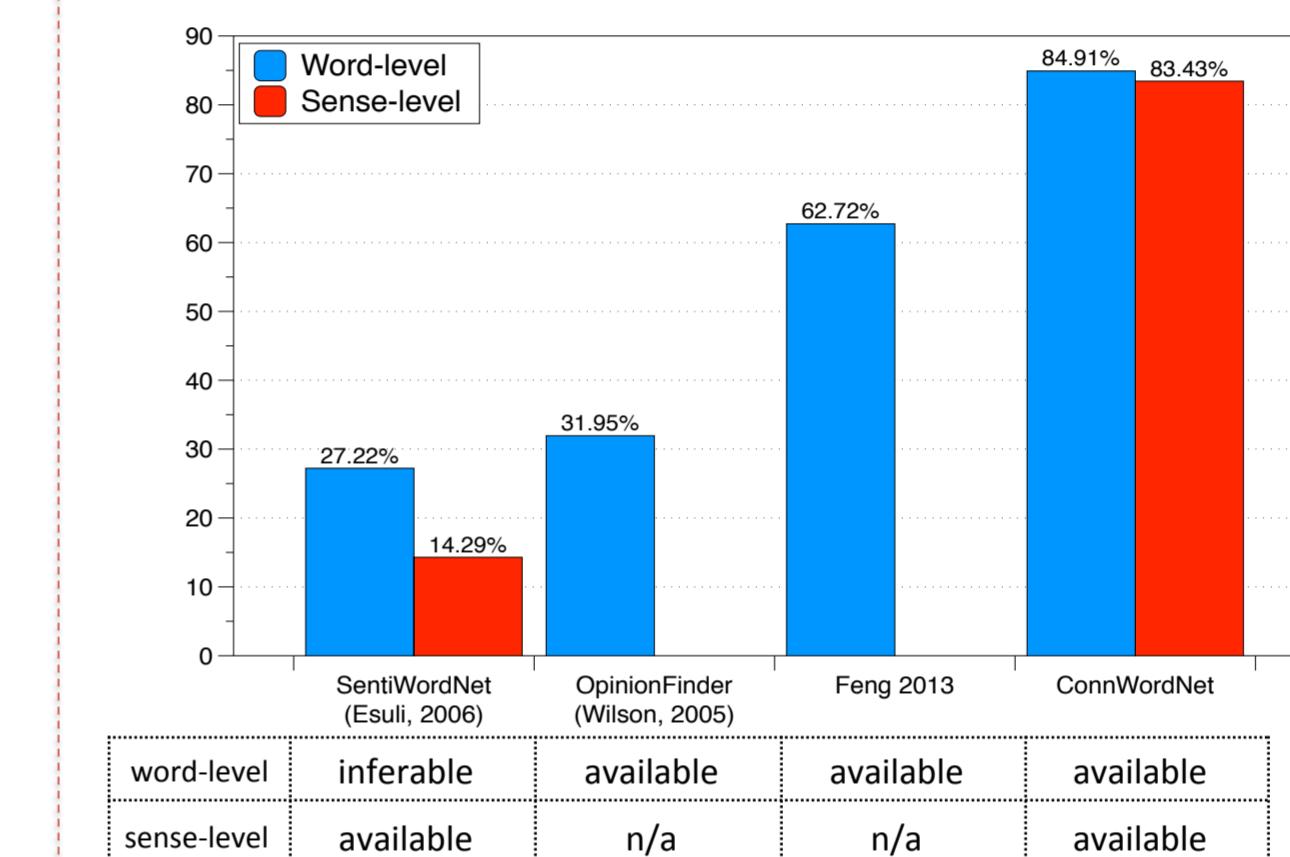
Evaluations

* Agreement with Sentiment Lexicons

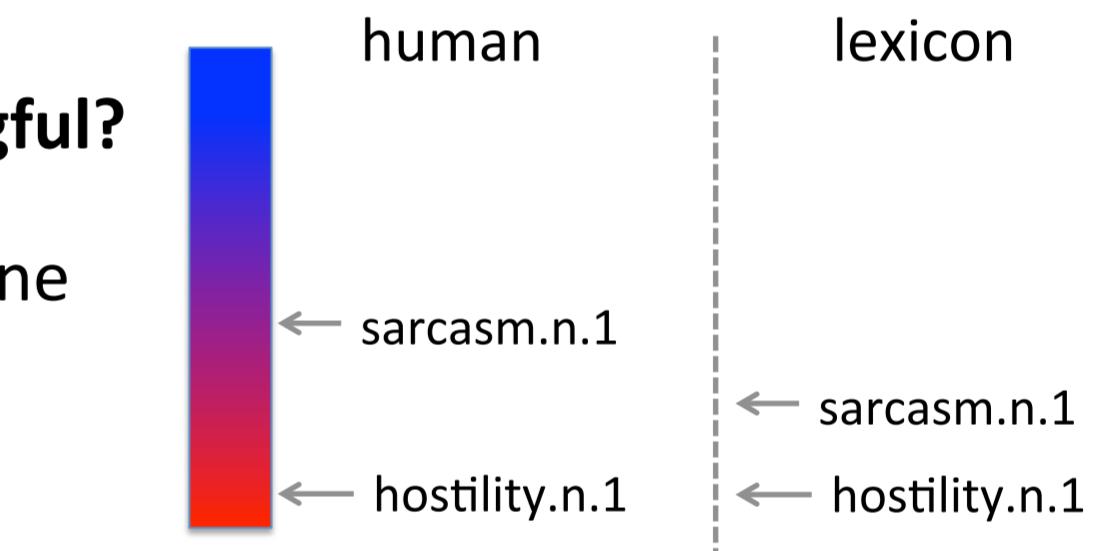


- GWord
- without senses
- synonyms, antonyms
- baseline-1/2
- Sub graphs of GWord
- Different graphs with same inference algorithm
- Impact of synonyms & antonyms
- Performance improvement is limited by the size of sentiment lexicon

* Agreement with Human Judges

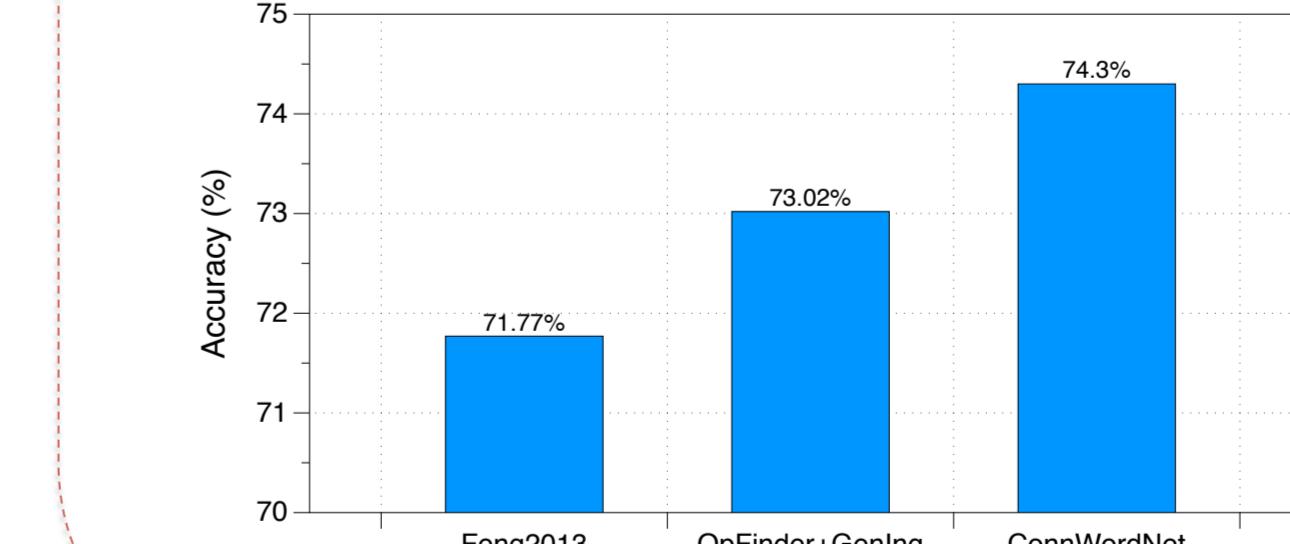


- Amazon Mechanical Turk
- 350 polysemous words and one of their senses
- connotative score: [-5, 5]
- averaged over 5 human judges
- Word-level
- SentiWordNet: inferred from sense-level scores
- OpinionFinder: low hit rate (34%)
- Sense-Level
- OpinionFinder & Our previous lexicon
- lacks sense-level labels



- ➔ Agreed!
 - human: "sarcasm.n.1" > "hostility.n.1"
 - lexicon: "sarcasm.n.1" > "hostility.n.1"
- SentiWordNet
 - Low accuracy
 - about 23% of pairs have the same scores
- OpinionFinder & Our previous lexicon
- ConnWordNet
 - Surprisingly good performance at sense-level

* Predicting Good/Bad News using ConnWordNet



- SemEval dataset (Strapparava and Mihalcea, 2007)
- Human labeled news headlines (good/bad)
- ConnWordNet outperformed combined sentiment lexicons

Conclusion

- A noble formulation of lexicon induction over word & sense network
- Introduction of Loopy Belief Propagation over pairwise MRF as a lexicon induction algorithm
- ➔ ConnWordNet
 - First lexicon that has polarity labels on both words & senses
 - Publicly available at http://www.cs.stonybrook.edu/~junkang/connotation_wordnet