Towards Bootstrapping a Polarity Shifter Lexicon using Linguistic Features

Marc Schulder
Michael Wiegand
Spoken Language Systems
Saarland University

Josef Ruppenhofer
Institute for German Language
Mannheim

Benjamin Roth
Center for Information and Language Processing
LMU Munich
What are Polarity Shifters?

Shifters, like negation words, move the polarity of a phrase towards the opposite of the polar term they contain.

**Negation**

*Peter [did not [pass]$^+$ the exam]$^-$.*
*They [did not [destroy]$^-$ the temple]$^+$.*

**Verbal Shifter**

*Peter [failed to [pass]$^+$ the exam]$^-$.  
They [failed to [destroy]$^-$ the temple]$^+$.  

Overview

- Motivation
- Bootstrapping a Lexicon
  - Features
  - Classification
  - Output Verification
- Extrinsic Evaluation
- Conclusion
## Negation VS Verbal Shifters

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- Vocabulary Size: 15% of verbs
- Individual Frequency: High
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**Individual Frequency**

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- Low

**Full Coverage**

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Pipeline

Large Shifter Lexicon
Pipeline

Large Shifter Lexicon

Expensive
Pipeline

Base Shifter Lexicon → Large Shifter Lexicon
Pipeline

Base Shifter Lexicon (labelled) → Classifier → Large Shifter Lexicon

Bootstrapping
Pipeline

Bootstrapping

Base Shifter Lexicon (labelled) → Features → Classifier → Large Shifter Lexicon
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Bootstrapping

Base Shifter Lexicon (labelled)

Features

Classifier

WordNet verbs (unlabelled)

Large Shifter Lexicon
Pipeline

Bootstrapping

Base Shifter Lexicon (labelled) → Features → Classifier → Verify Shifters → Large Shifter Lexicon

WordNet verbs (unlabelled)
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WordNet verbs (unlabelled)
Generic Features

WordNet

- **Glosses**: Word definition (bag-of-words).
- **Hypernyms**: Words with more general meaning.
- **Supersenses**: Coarse semantic categories.

FrameNet

- **Verb Frames**: Semantic verb groups.
  Frame AVOIDING: desist, dodge, evade, shun, shirk,...
Task-specific Features

1. Distributional Similarity
Choose verbs similar to negation words like *not*, *no*, etc.

2. Polarity Clash
Negative verb with positive object.
*She [lost [hope]^+]*. 

3. Particle Verbs
Some particles indicate "loss" (e.g. *aside*, *down*, *off*, ...).
*Please [lay aside all your [worries]^]-*.

4. any-Heuristic
The word *any* co-occurs with negation/shifters.
*They did [not give us any [help]^+]*.
*They [denied us any [help]^+]*.
Anti-Shifter Feature

Anti-Shifter:
Co-occurrence with adverbs that are
• attracted to verbs of creation;
• repelled by verbs of destruction.

Black bears exclusively live on fish.
Keyboards on phones were first introduced in 1997.
These buildings have been newly constructed.
They specially prepared vegan dishes for me.
Pipeline

Bootstrapping

Base Shifter Lexicon (labelled)

Features

Classifier

Verify Shifters

Large Shifter Lexicon

WordNet verbs (unlabelled)

2000 verbs

304 shifters

8581 verbs
Classifier Setup

SVM

- **Training:** Base Lexicon
  - 2000 verbs, incl. 304 shifters
- **Labels:** Shifter, non-shifter
- **Evaluation:** 10-fold cross validation
Classifier Setup

SVM

• **Training**: Base Lexicon
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• **Labels**: Shifter, non-shifter

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Baselines

• **Majority Label**: All verbs are non-shifters
Classifier Setup

SVM

- **Training:** Base Lexicon
  2000 verbs, incl. 304 shifters
- **Labels:** Shifter, non-shifter
- **Evaluation:** 10-fold cross validation

Baselines

- **Majority Label:** All verbs are non-shifters
- **Graph Clustering** (Approach with no labelled training data)
  - **Input:** Word Embedding Graph + Seeds
  - **Positive Seeds:** ANY (best shifter feature)
  - **Negative Seeds:** ANTI
Classifier Performance

Macro F1

- Majority: 0.46
- Graph Clustering: 0.62
- SVM: 0.79
Pipeline

Bootstrapping

Base Shifter Lexicon (labelled)

Features

Classifier

Verify Shifters

Large Shifter Lexicon

2000 verbs

304 shifters

8581 verbs

WordNet verbs (unlabelled)

1043 shifters

2000 verbs

304 shifters
Shifter Verification

- **Task:** Human annotator verifies predicted shifters.
- **Input:** 1043 verbs predicted as shifters.
- **Output:** 676 verbs confirmed as shifters.

![Bar chart showing precision for different classifier confidence ranking ranges:](chart.png)

- **1-250:** Precision = 0.93
- **251-500:** Precision = 0.73
- **501-750:** Precision = 0.62
- **751-1043:** Precision = 0.33
Pipeline

Bootstrapping

2000 verbs
Base Shifter Lexicon (labelled)

304 shifters
Features

8581 verbs
WordNet verbs (unlabelled)

676 shifters
Verify Shifters

877 verbs
Large Shifter Lexicon

304 shifters
WordNet verbs (unlabelled)
Pipeline

Bootstrapping

Base Shifter Lexicon (labelled) -> Features -> Classifier -> Verify Shifters

WordNet verbs (unlabelled)

Large Shifter Lexicon

2000 verbs

304 shifters

676 shifters

304 + 676 = 980 shifters

8581 verbs

802 verbs

676 shifters

304 + 676 = 980 shifters

Marc Schulder
Fine-grained Sentiment Analysis Pipeline

- **Base Shifter Lexicon** (labelled) contains 2000 verbs and 304 shifters.
- **Features** include 8581 verbs (unlabelled).
- **Classifier** uses these features.
- **Verify Shifters** process 676 shifters.
- **Large Shifter Lexicon** contains 304 + 676 = 980 shifters.

Total shifters: 980

Fine-grained Sentiment Analysis
Extrinsic Evaluation

Sentiment Analysis

Task:
Given a verb phrase with a polar noun, decide whether phrase polarity has shifted from the polarity of the noun.

Input: *Norah Jones’ smooth voice could [soothe\textsubscript{V} any savage [beast\textsubscript{N}]\textsuperscript{-}]\textsubscript{VP}.*

Output Labels: Shifted, not shifted

Gold Data: Amazon Product Review Corpus (Jindal and Liu, 2008)
2631 phrases
Balanced for ratio of shifters among verbs.
Extrinsic Evaluation

Classifiers

Proposed Classifier using Bootstrapped Lexicon

• If verb in shifter lexicon $\Rightarrow$ Shifted
Extrinsic Evaluation

Classifiers

Proposed Classifier using Bootstrapped Lexicon

• If verb in shifter lexicon $\Rightarrow$ Shifted

Baselines

• Majority Label: All sentences are not shifted.
Proposed Classifier using Bootstrapped Lexicon
• If verb in shifter lexicon $\Rightarrow$ Shifted

Baselines
• **Majority Label:** All sentences are not shifted.
• **Recursive Neural Tensor Network** (Socher et al., 2013)
  • Compositional sentence-level polarity classifier.
  • Provides polarities for each constituency tree node.
  • No explicit knowledge of shifters.
Extrinsic Evaluation
Results

<table>
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<tr>
<th>Method</th>
<th>Macro F1</th>
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<tbody>
<tr>
<td>Majority</td>
<td>0.44</td>
</tr>
<tr>
<td>RNTN</td>
<td>0.51</td>
</tr>
<tr>
<td>LEX</td>
<td>0.8</td>
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Conclusion

• Produced a large lexicon of 980 shifters. Available at https://github.com/marcschulder/ijcnlp2017
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• Bootstrapping reduces cost of high quality annotation.
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• Bootstrapping **reduces cost** of **high quality** annotation.

• Explicit knowledge of shifters **improves**
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Conclusion

- Produced a large lexicon of 980 shifters. Available at [https://github.com/marcschulder/ijcnlp2017](https://github.com/marcschulder/ijcnlp2017)
- Bootstrapping reduces cost of high quality annotation.
- Explicit knowledge of shifters improves fine-grained sentiment analysis.
- Introduced linguistic indicators for polarity shifting:
  - Any-Heuristic
  - Verb Particles
  - Anti-Shifter Adverbs
Thank You
References


Conclusion

• Produced a **large lexicon** of 980 shifters. Available at [https://github.com/marcschulder/ijcnlp2017](https://github.com/marcschulder/ijcnlp2017)

• Bootstrapping **reduces cost** of **high quality** annotation.

• Explicit knowledge of shifters **improves** **fine-grained sentiment analysis**.

• Introduced **linguistic indicators** for polarity shifting:
  • Any-Heuristic
  • Verb Particles
  • Anti-Shifter Adverbs
Low Ressource Languages

![Bar chart showing Macro F1 scores for different methods: Majority, Graph Clustering, SVM (task), SVM (generic), SVM (all). The scores are 0.46, 0.62, 0.68, 0.77, and 0.79 respectively.](chart.png)
Low Resource Languages

Amount of data used for training in 10-fold cross-validation

- SVM (all)
- SVM (generic)
- SVM (task)
- Graph Clustering
Polarity Shifters

- Shifting can happen in either direction.  
  *She was [denied the [scholarship]+]*.
  *The new medication [alleviated her [pain]+]*.

- Shifter words can have neutral polarity.  
  *Homework [[eats up]~ all my [free time]+]*.

- Polarity of shifter word ≠ direction of shifting.  
  *You should [[abandon]~ your [fears]+]*.
Data

Polarity Lexicon
• Subjectivity Lexicon (Wilson et al. 2005)

Word Embeddings
• Tool: Word2Vec (Mikolov et al., 2013)
• Corpus: Amazon Product Review Corpus (Jindal and Liu, 2008)
  (also used for co-occurrence counts and extrinsic eval)

Graph Ranking:
• Tool: Junto (Talukdar et al., 2008)
• Algorithm: Adsorption Label Propagation (Talukdar et al., 2008)
Any Heuristic

Negative polarity items (NPI) like *any* occur in the context of negation. (Giannakidou, 2008) We hypothesise the same for shifters.

\[\text{They [did not give us any [help]+]}.\]
\[\text{They [denied us any [help]+]}.\]

**Pattern**
\[\text{(VP VERB (NP any POLAR_NOUN))}\]

**Restriction:** Noun must be polar

**Ranking:** Pattern Frequency / Verb Frequency

**Re-Ranking:** Personalised PageRank (Agirre and Soroa, 2009)
RNTN: Data Sparsity

**Training:** Sentiment Treebank (Socher et al., 2013)

**Size:** 11,855 sentences;
   215,154 phrase nodes

**Advantage:** Explicit polarities for every tree node.

**Disadvantage:** Few or no instances of most verbs.
   $\Rightarrow$ Difficult to learn shifter behaviour