German in Flux: Detecting Metaphoric Change via Word Entropy
Dominik Schlechtweg, Stefanie Eckmann, Enrico Santus, Sabine Schulte im Walde, Daniel Hole

Introduction
- our aim:
  - overall: build a computational model detecting semantic change
  - in this paper: distinguish metaphoric change from semantic stability
- how we do it:
  - exploit the idea of semantic generality from hypernym detection
  - apply entropy to distributional semantic model (Santus, Lenci, Lu, & Schulte im Walde, 2014)
  - sample language German
  - introduce the first resource for evaluation of models of metaphoric change

Metaphoric Change
- frequent and important type of semantic change
- source and target concept are related by similarity or a reduced comparison (cf. Koch, 2016, p. 47)
  source: ‘... muß ich mich umbewerten, und kann keinen schlaff in meine augen bringen,...’
  target: ‘Kinadon wollte den Staat unmüllen.’
  ‘Kinadon wanted to revolutionize the state....’
  (i) creates polysemy
  (ii) often results in more abstract or general meanings
  → assumption: (i) and (ii) imply extension and dispersion in the range of linguistic contexts

Related Work
- previous work includes mainly:
  i) spatial displacement models
  ii) word sense induction models
- quantifies the degree of overall change rather than being able to qualify different types
- does not examine metaphoric change

Conclusions
- you can annotate semantic change in a corpus (so do it)
- entropy correlates strongly and significantly with degree of metaphoric change
- frequency correlates moderately, but non-significantly on small data set
- annotation and model are generalizable to different types of semantic change

Word Entropy
- derived from information-theoretic concept of entropy (Shannon, 1948)
  - corresponds to entropy of word vector
  - is assumed to reflect semantic generality in hypernym detection
  - is given by
    \[
    H(C) = -\sum_{i=1}^{n} P(c_i | w) \log_2 P(c_i | w)
    \]
    where \( P(c_i | w) \) is the occurrence probability of context word \( c_i \) given target word \( w \)
  - measures the unpredictability of \( w \)’s co-occurrences

Evaluation
- no standard test set of semantic or metaphoric change
- we create a small but first test set via annotation (28 items)
  - annotators judged 560 context pairs for a metaphorical relation
  Workflow:
  i) preselect 14 changing words
  ii) add 14 stable distractors
  iii) identify a date of change
  iv) extract 20 contexts for each target from before and after date of change
  v) for each word combine contexts between time periods randomly
  vi) annotation of context pairs

Results

<table>
<thead>
<tr>
<th></th>
<th>1700-1800</th>
<th>1800-1900</th>
<th>all</th>
</tr>
</thead>
<tbody>
<tr>
<td>entropy</td>
<td>.64***</td>
<td>.10</td>
<td>.39*</td>
</tr>
<tr>
<td>frequency</td>
<td>29</td>
<td>-0.7</td>
<td>.26</td>
</tr>
</tbody>
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Table 1: Correlation (\( \rho \)) between predicted and gold ranks. Significance is determined with a t-test.

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Acknowledgements
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