Characterizing the pragmatic component of distributional vectors in terms of polarity: Experiments on German über verbs

Gabriella Lapesa, Max Kisselew, Sebastian Padó, Tilmann Pross, Antje Roßdeutscher

Universität Stuttgart, Institut für Maschinelle Sprachverarbeitung
The phenomenon: *über* ("over") prefix verbs

- Very productive derivational pattern in German
- The prefix has the same form of a directional/locational preposition

\[ \text{über etwas fahren} \]
"drive over something"

\[ \text{etwas überfahren} \]
"run something over"

- Some *über*- verbs (e.g., *überrollen*, "invade", *überfluten*, "overflood") exhibit a negative evaluative meaning component
  → **can we capture it with a distributional semantic approach?**
83 base verbs paired with the corresponding über- derivation:
- *rollen* – *überrollen* ("roll" – “invade”)
- *bringen* – *überbringen* ("bring" – “deliver’)

All derived words transparent with respect to their bases (at least in their main reading)

Annotation as a basis for analysis:
- Base: WordNet topnodes, number of synsets
- Derived: manual classification based on lexical-semantic properties of the über derivation
Characterizing the *über* shift: four classes

**ACROSS**
Movement across some obstacle, region as a patient (in some cases undergoes change of state)

*überfahren*, “run something over”

**MORE**
Exceeding of a threshold on a scale provided by the base verb

*überbewerten*, “overvalue”

**TRANSFER**
Displacement of an object from a source region to a goal region

*überbringen*, “deliver”

**APPLICATION**
An object is applied to another object and it fully covers it

*überkleben*, “paste over”
Lexical-semantic properties and predictions\textsuperscript{1}:

- **ACROSS**: motion event has negative consequences (\textit{überrollen}, “invade, infest”)
- **APPLICATION**: some base verbs have a \texttt{-CONTROL} component which gets emphasized by telicity (\textit{überfluten}, “overflood”)
- **MORE** verbs can be positive or negative (scale and thresholds are contextually supplied)

\textsuperscript{1}Week 2: Roßdeutscher et al. in the RefSemPlus workshop
The evaluative component of distributional vectors

**Context set subspace** (Herbelot and Copestake, 2013)

DSMs as *ideal distribution*: a language model built by accumulating all the contexts in which a target lexeme occurs; **context set subspace** as a conceptual tool for “zooming in” on theoretically motivated portions of the ideal distribution.

Focus on the **pragmatic context set subspace**:

- Evaluative considerations systematically affect text planning
- Evaluative considerations that are frequent enough become *part of the meaning* of the target word.
Distributional methodology: ingredients

- **Count DSM** (interpretable dimensions):
  - SdeWaC web corpus: 800 mln words (Faaß and Eckart, 2013)
  - Large target and context vocabulary: 280k lemmatized words (DERivBase, Zeller et al. 2013)
  - Symmetric context window, 5 words
  - PPMI

- **German Affectivity Norms** (Köper and Schulte Im Walde, 2016):
  - 350k target words
  - Semi-automatically generated ratings (scale 0-10)

  1. **Valency**: is the emotion associated with the referent positive or negative?
  2. **Concreteness**: can the referent be perceived?
  3. **Imageability**: can the referent be perceived visually?
  4. **Arousal**: how intense is the emotion associated with the referent?
**Distributional methodology: affective score computation**

**DSM**

<table>
<thead>
<tr>
<th></th>
<th>c1</th>
<th>c2</th>
<th>c3</th>
<th>c4</th>
<th>c5</th>
</tr>
</thead>
<tbody>
<tr>
<td>w1</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>w2</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>w3</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**Feature selection + L1 norm**

<table>
<thead>
<tr>
<th>Feature</th>
<th>w1</th>
<th>w2</th>
</tr>
</thead>
<tbody>
<tr>
<td>c1</td>
<td>0.4</td>
<td>0.1</td>
</tr>
<tr>
<td>c2</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>c3</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>c5</td>
<td>0.2</td>
<td>0.2</td>
</tr>
</tbody>
</table>

**Proportion of the distributional profile accounted for by each feature**

**AFFECTIVITY NORMS**

<table>
<thead>
<tr>
<th></th>
<th>VAL</th>
<th>ARO</th>
<th>IMG</th>
<th>CNC</th>
</tr>
</thead>
<tbody>
<tr>
<td>c1</td>
<td>9</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>c2</td>
<td>3</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>c3</td>
<td>1</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>c5</td>
<td>2</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

**Weight vectors: settings**

**V\_plain**

<table>
<thead>
<tr>
<th>Feature</th>
<th>c1</th>
<th>c2</th>
<th>c3</th>
<th>c5</th>
</tr>
</thead>
<tbody>
<tr>
<td>c1</td>
<td>9</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>c2</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>c3</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>c5</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**V\_quartile**

<table>
<thead>
<tr>
<th>Feature</th>
<th>c1</th>
<th>c2</th>
<th>c3</th>
<th>c5</th>
</tr>
</thead>
<tbody>
<tr>
<td>c1</td>
<td>9</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>c2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>c3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>c5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**V\_binary**

<table>
<thead>
<tr>
<th>Feature</th>
<th>c1</th>
<th>c2</th>
<th>c3</th>
<th>c5</th>
</tr>
</thead>
<tbody>
<tr>
<td>c1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>c2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>c3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>c5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

**Highest and lowest 25%**

**Binarization**
Distributional methodology: affective score computation

- **Valency score**: inner product between target vector and weight vector:
  - High $\uparrow$: if most contexts have positive valency
  - Low $\downarrow$: if most contexts have negative valency
- We calculated:
  - A valency score for each item in the dataset (base and derived)
  - Imageability, concreteness and arousal scores
  - The corresponding **shift scores** (derived - base)
Study 1: the evaluative component of über verbs

Questions

Q1: Do the annotated über classes differ with respect to their added evaluative load?
Q2: Does the literal/metaphorical divide modulate the evaluative component?

Linear regression analysis:

- **Predicted value**: valency score
- **Predictors**:
  - Q1: Class labels (reference level: TRANSFER)
  - Q1: Arousal
  - Q2: Imageability
  - Q1/Q2: Interactions between class and imageability/arousal
- **Covariates**: frequency base (***(**), frequency derived (***(**), base WordNet topnode (n.s.), base nr of synsets (n.s.)
Study 1: the evaluative component of *über* verbs

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPLICATION</td>
<td></td>
</tr>
<tr>
<td>ACROSS</td>
<td></td>
</tr>
<tr>
<td>MORE</td>
<td></td>
</tr>
<tr>
<td>Imageability</td>
<td>* ↓</td>
</tr>
<tr>
<td>Arousal</td>
<td></td>
</tr>
<tr>
<td>ACROSS:arousal</td>
<td>*** ↓</td>
</tr>
<tr>
<td>APPLICATION:arousal</td>
<td></td>
</tr>
<tr>
<td>MORE:arousal</td>
<td></td>
</tr>
</tbody>
</table>

**Model fit (Adj.$R^2$)** 56% (***)

$\downarrow = \text{negative valency}; \uparrow = \text{positive valency}$
Q1: evaluative load of über classes:
   - Strong negative effect of arousal on ACROSS verbs

Q2: interaction with literal/metaphorical uses:
   - Negative effect of imageability on valency:
     → Literal uses more negative – work in progress: qualitative analysis of actual instances

Q3: are the tendencies we identified common to other derivational patterns?

Q4: can we characterize the über shift in terms of more fine-grained emotions?
Study 2: comparison to other derivational patterns

- We compare the whole über class it to six derivational patterns (Kisselew et al. 2015):
  - N→N: FEMALE (-in), SMALL (-chen)
  - A→A: ADVERSATIVE (anti-), NEGATIVE (un-)
  - V→V: THROUGH (durch-), INCHIOATIVE (an-)

- Linear regression\(^2\) as in Study 1:
  - über-wise: no main effect, no interactions
  - it makes sense to approach über per subclasses
  - Strong overall negative effect of concreteness on valency (** ↓)
  - Strong interactions between concreteness and non über patterns, no interactions with arousal (specific feature of über)
  - Interesting non über result: significant positive (*) ↑ effect for the FEMALE pattern: female forms are used in more positive contexts than their male counterparts

\(^2\)Adj.R\(^2\)=36% (***)

Lapesa, Kisselew, Padó, Pross, Roßdeutscher

The pragmatic component of German über verbs
Study 3: the emotional component of the über shift

- Resource: **German Emotion Dictionary** (Klinger et al. 2016)
- Approx 4000 words in total, unweighted
- Seven emotions: joy, anger, fear, surprise, contempt, disgust, and sorrow
- Linear regression$^3$: **emotional shift** as predicted value, emotions (joy, fear, etc.) and class (ACROSS, MORE, etc.) as predictors
- Results:
  - Less joy (*) for ACROSS verbs than the respective bases
  - More surprise (*) for MORE verbs
  - More anger (**) for APPLICATION verbs

$^3$Adj.$R^2$=7% (**)
We presented a strategy for the characterization of the pragmatic component encoded in distributional vectors.

We employed the notion of pragmatic context set subspace to detect evaluative shifts and their interaction with other meaning dimensions (imageability, arousal).

Ongoing work:
- Improving the method for the detection of emotional shifts
- Bringing more derivational patterns into the picture (also pos-changing ones)
Thank you!