Towards a Dutch Frame-Semantic Parser

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Introduction: FrameNet

- Lexical resource based on **Frame Semantics** (Fillmore): aims to describe the meanings of lexical items and grammatical constructions in terms of **semantic frames**

[Grandmother] **baked** [us] [a pie] [from rhubarb and strawberries]

- **Frame**: Cooking_creation
- **Frame Elements**: Cook, Recipient, Produced_food and Ingredients

https://framenet.icsi.berkeley.edu/fndrupal/
Introduction: Frame-Semantic Parsing

- Automatically extracting frame-semantic structures (using FrameNet as repository) from text in three steps:
  1. Target identification
  2. Frame identification
  3. Frame element identification (or SRL)

- Most research has focused on English; this research focuses on Dutch
Research problem

**Goal:** Frame-semantic parsing in Dutch

**Problem:** No data annotated with frames and frame elements (FEs) in Dutch

**But we do have...**

✓ SSRL: Dutch PropBank-style SRL-system (De Clerq et al. 2012)
✓ Mappings between English FrameNet and PropBank
✓ Mappings between English and Dutch predicates

**Possible solution:** Map English FrameNet frames and FEs onto PropBank roles generated by SoNaR Semantic Role Labeler (SSRL)
Possible solution: Map (English) FrameNet frames and FEs onto PropBank roles generated by SSRL

[Oma] bakte [voor ons] [een taart] [van rabarber en aardbeien].

Arg0       Arg3       Arg1       Arg2
Possible solution: Map (English) FrameNet frames and FEs onto PropBank roles generated by SSRL

[Oma] bakte [voor ons] [een taart] [van rabarber en aardbeien].

Arg0 Arg3 Arg1 Arg2

1. From Dutch to English: bakken → bake (= Cooking_Creation)
   ✤ WordNet alignments
   ✤ Machine translations
Possible solution: Map (English) FrameNet frames and FEs onto PropBank roles generated by SSRL

[Oma] bakte [voor ons] [een taart] [van rabarber en aardbeien].

Arg0      Arg3      Arg1      Arg2

1. From Dutch to English: bakken → bake (= Cooking_Creation)
   ✤ WordNet alignments
   ✤ Machine translations

2. From PropBank to FrameNet: Arg0 → Cook
   ✤ SemLink
   ✤ Predicate Matrix
   ✤ Cross-annotations
FrameNet, VerbNet, PropBank

<table>
<thead>
<tr>
<th>FrameNet</th>
<th>VerbNet</th>
<th>PropBank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cook</td>
<td>Agent</td>
<td>Arg0</td>
</tr>
<tr>
<td>Produced_food</td>
<td>Patient</td>
<td>Arg1</td>
</tr>
<tr>
<td>Ingredients</td>
<td>Material</td>
<td>Arg2</td>
</tr>
<tr>
<td>Recipient</td>
<td>Beneficiary</td>
<td>Arg3</td>
</tr>
</tbody>
</table>
Mappings between resources

- FrameNet, PropBank and VerbNet created independently with somewhat different goals and different representations, but: **complementary rather than conflicting**
  - PropBank: best coverage and largest corpus for training supervised systems
  - VerbNet: clearest link between syntax and semantics
  - FrameNet: provides richest semantics

- Several attempts to create **mappings** between predicates:
  - SemLink (Bonial et al. 2013)
  - Predicate Matrix (Lopez de Lacalle et al. 2014)
  - Cross-annotations (Laparra Martín 2014)
SemLink (release 1.2.2)

- Mappings between VerbNet-PropBank and VerbNet-FrameNet
- **Lexical mappings**: specify *potential* mappings
  - e.g. for the verb *wake* Arg0 can be either Agent or Cause in the Cause_to_wake frame
- **Corpus mappings**: specify *actual* occurrences of mappings in text
  - e.g. Arg0-Cause in *the rain woke me*
  - Wall Street Journal: partly manually annotated and partly automatically annotated (if lexical mapping was one-to-one)

https://verbs.colorado.edu/semlink/
Predicate Matrix

- Extension of SemLink: all predicate information mapped to WordNet senses
- Mappings between VerbNet-PropBank-FrameNet-WordNet
- Lexical mappings only

http://adimen.si.ehu.es/web/PredicateMatrix
## Predicate Matrix

<table>
<thead>
<tr>
<th></th>
<th>row (1)</th>
<th>row (2)</th>
<th>row (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WN_SENSE</strong></td>
<td>accept%2:31:00</td>
<td>accept%2:31:00</td>
<td>admonish%2:32:00</td>
</tr>
<tr>
<td><strong>VN_CLASS</strong></td>
<td>accept-77</td>
<td>accept-77</td>
<td>advise-37.9</td>
</tr>
<tr>
<td><strong>VN_SUBCLASS</strong></td>
<td>NULL</td>
<td>NULL</td>
<td>advise-37.9-1</td>
</tr>
<tr>
<td><strong>VN_LEMMA</strong></td>
<td>emphathise</td>
<td>emphatise</td>
<td>admonish</td>
</tr>
<tr>
<td><strong>VN_ROLE</strong></td>
<td>Agent</td>
<td>Theme</td>
<td>Agent</td>
</tr>
<tr>
<td><strong>FN_FRAME</strong></td>
<td>Awareness</td>
<td>Awareness</td>
<td>Attempt_suasion</td>
</tr>
<tr>
<td><strong>FN_LU</strong></td>
<td>understand.v</td>
<td>understand.v</td>
<td>admonish.v</td>
</tr>
<tr>
<td><strong>FN_ROLE</strong></td>
<td>Cognizer</td>
<td>Content</td>
<td>Content</td>
</tr>
<tr>
<td><strong>PB_ROLESET</strong></td>
<td>understand.01</td>
<td>understand.01</td>
<td>admonish.01</td>
</tr>
<tr>
<td><strong>PB_ROLE</strong></td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
Cross-annotations

- Coverage of SemLink/Predicate Matrix not enough; Laparra Martín (2014) created a corpus of cross-annotations
  - PropBank annotations automatically added to FrameNet corpus
  - FrameNet annotations automatically added to PropBank corpus
- Mappings between PropBank/NomBank and FrameNet
- Corpus mappings only (but: large corpus)

Mappings between languages

- Alignments between Dutch (Cornetto) and English WordNets (Princeton WordNet)
  - Provide ‘translations’ at sense-level (synsets); especially useful if you have good WSD system! (better precision)
  - voorzien → <provide, supply, cater> (“give what is desired or needed, especially support, food or sustenance”)

- Machine translations
  - Provide translations at lemma-level (better recall)
  - voorzien → provide
Data collection (test)

- News texts (project NewsReader)
- Annotated by two linguistically-trained undergraduate students and native speakers of Dutch
- Inter-annotator agreement:
  - Frame identification: 50%
  - FE identification: 91%
  - Most of the disagreements related to minimal semantic distinctions between frames (e.g. Getting vs. Receiving)
- Pre-processing of data: NewsReader pipeline (tokenization, morpho-syntactic parsing, WSD, PropBank-style SRL)
## Experiments

<table>
<thead>
<tr>
<th>Experiment</th>
<th>PropBank &gt; FrameNet</th>
<th>Dutch &gt; English</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>Predicate Matrix</td>
<td>Cornetto-WordNet</td>
</tr>
<tr>
<td>1(b)</td>
<td>Predicate Matrix</td>
<td>Machine translations</td>
</tr>
<tr>
<td>2(a)</td>
<td>SemLink</td>
<td>Cornetto-WordNet</td>
</tr>
<tr>
<td>2(b)</td>
<td>SemLink</td>
<td>Machine translations</td>
</tr>
<tr>
<td>3(a)</td>
<td>Cross-annotations</td>
<td>Cornetto-WordNet</td>
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<tr>
<td>3(b)</td>
<td>Cross-annotations</td>
<td>Machine translations</td>
</tr>
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Evaluation

- Average precision, recall, F1-score
- Frame identification and FE identification evaluated as isolated tasks: gold frames given for FE identification
- Separate scores for **exact matching** and **partial matching**: also credits for frames that are close to gold frames (e.g. Getting vs. Receiving)
## Results: Frame identification

<table>
<thead>
<tr>
<th>system</th>
<th>resource</th>
<th>translation</th>
<th>exact matching</th>
<th>partial matching</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>precision</td>
<td>recall</td>
</tr>
<tr>
<td>PM</td>
<td>Co-WN</td>
<td></td>
<td>0.13</td>
<td>0.34</td>
</tr>
<tr>
<td>PM</td>
<td>MT</td>
<td></td>
<td>0.10</td>
<td>0.43</td>
</tr>
<tr>
<td>SL</td>
<td>Co-WN</td>
<td></td>
<td>0.19</td>
<td>0.32</td>
</tr>
<tr>
<td>SL</td>
<td>MT</td>
<td></td>
<td>0.21</td>
<td>0.35</td>
</tr>
<tr>
<td>CA</td>
<td>Co-WN</td>
<td></td>
<td>0.36</td>
<td>0.36</td>
</tr>
<tr>
<td>CA</td>
<td>MT</td>
<td></td>
<td>0.34</td>
<td>0.34</td>
</tr>
</tbody>
</table>
### Results: FE identification

<table>
<thead>
<tr>
<th>system resource</th>
<th>translation</th>
<th>precision</th>
<th>recall</th>
<th>F1-score</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM</td>
<td>Co-WN</td>
<td>0.73</td>
<td>0.21</td>
<td>0.32</td>
</tr>
<tr>
<td>PM</td>
<td>MT</td>
<td>0.69</td>
<td>0.27</td>
<td>0.39</td>
</tr>
<tr>
<td>SL</td>
<td>Co-WN</td>
<td>0.88</td>
<td>0.24</td>
<td>0.37</td>
</tr>
<tr>
<td>SL</td>
<td>MT</td>
<td>0.92</td>
<td>0.17</td>
<td>0.28</td>
</tr>
<tr>
<td>CA</td>
<td>Co-WN</td>
<td>0.75</td>
<td>0.37</td>
<td>0.49</td>
</tr>
<tr>
<td>CA</td>
<td>MT</td>
<td>0.79</td>
<td>0.34</td>
<td>0.47</td>
</tr>
</tbody>
</table>
Conclusion

- Best system: F1-score of 0.41 and 0.49 on frame and FE identification respectively and there is still room for improvement
  - Cross-annotations performed best because of their coverage and availability of frequency information
- Mappings like SemLink, Predicate Matrix and cross-annotations indeed offer great potential for frame-semantic parsing in a cross-lingual setting
Discussion: annotation and evaluation

- Fine-grained nature of FrameNet
  - Minimal semantic differences between frames
  - In many cases more than one frame may be applicable

- Implications for annotations
  - IAA of only 50%

- Implications for evaluation
  - Some frames less ‘wrong’ than others; how can we measure this?
  - Difficult to use frame hierarchy of FrameNet because of many inconsistencies and gaps
Event

- Rotting
  - Ingest_substance
    - Processing_materials
  - Intentionally_act
    - Intentionally_affect
      - Hiring
        - 39 children in total

- 28 children in total
- 52 children in total
Next steps?

- Improvements on coverage of the Predicate Matrix and WordNet alignments are on their way
- Improvement of WSD-system
- Combining synset information provided by WordNet alignments and the Predicate Matrix with frequency, contextual and structural information provided by corpus mappings (such as the cross-annotations)
Het gadget [...] wordt voorzien van een hele rits verschillende bandjes. “The gadget [...] will be equipped with a range of different straps.”
References


