Comprehensive Supersense Disambiguation of English Prepositions and Possessives

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Adpositions are Pervasive

- Adpositions: prepositions or postpositions
Prepositions are some of the most frequent Words in English

Based on the COCA list of 5000 most frequent words
We know Prepositions are challenging for Syntactic Parsing

a talk at the conference on prepositions

But what about the meaning beyond linking governor and object?
Prepositions are highly Polysemous

• *in*
  • *in* the box
  • *in* the afternoon
  • *in* love, *in* trouble
  • *in* fact
  • ...

• *for*
  • leave *for* Paris
  • ate *for* hours
  • a gift *for* mother
  • raise money *for* the party
  • ...

Translations are Many-to-Many

*pour*
- raise money to buy a house
- *pendant*
  - for
    - raise money for the church
    - a gift for mother
  - to
    - *à*
      - give the gift to mother
      - go to Paris
  - *à*
    - ate for hours
Potential Applications

• Machine Translation
  • MT into English: mistranslation of prepositions among most common errors
    \( (\text{Hashemi and Hwa, 2014; Popović, 2017}) \)

• Grammatical Error Correction

• Semantic Parsing / SRL
Goal: Disambiguation

- Descriptive theory (annotation scheme)
- Lexical resource
- Annotated Dataset
- Disambiguation system (classifier)
Our Approach

1. Coarse-grained supersenses
2. Comprehensive with respect to naturally occurring text
3. Unified scheme for prepositions and possessives
4. Scene role and preposition’s lexical contribution are distinguished

In this paper: English
Senses vs. Supersenses

over
  • preposition
    » 1. extending directly upwards from: I saw flames over Berlin | cook the sauce over a moderate heat.
    » 2. at a higher level or layer than: his flat was over the shop.
    » 3. higher or more than (a specified number or quantity): over 40 degrees C | they've been married for over a year.
    » 4. expressing passage or trajectory across: she trudged over the lawn.
    » 5. expressing duration: you've given us a lot of heartache over the years | she told me over coffee.
    » 6. expressing the medium by which something is done; by means of: a voice came over the loudspeaker.
      • by means of the resistant surface constituted by (an object)
    » 7. on the subject of: a heated debate over unemployment.

Senses (e.g., Over-15-1)  Supersenses (e.g., Frequency)
Challenges for Comprehensiveness

• What counts as a preposition/possessive marker?
  • Prepositional multi-word expressions ("of course")
  • Phrasal verbs ("give up")
  • Rare senses (RateUnit, “40 miles per Gallon”)
  • Rare prepositions ("in keeping with")
  • ...

• Wicked polysemy
Supersense Inventory

• Semantic Network of Adposition and Case Supersenses (SNACS)

• 50 supersenses, 4 levels of depth

• Simpler than its predecessor (Schneider et al., 2016)
  • Fewer categories, smaller hierarchy
Supersense Inventory

• **Participant**
  • Usually core semantic roles

• **Circumstance**
  • Usually non-core semantic roles

• **Configuration**
  • Non-spatiotemporal information
  • Static relations
• **Challenge:** the preposition itself and the verb may suggest different labels

1. Vernon works **at** Grunnings

2. Vernon works **for** Grunnings

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Similar meanings: the same label?

- “at Grunnings”: **Locus** or **OrgRole**?
- “for Grunning”: **Beneficiary** or **OrgRole**?

• **Approach:** distinguish *scene role* and *preposition function*
Construal

• Scene role and preposition function may diverge:

   \textit{Locus} \rightarrow \textit{OrgRole}

1. Vernon works \textbf{at} Grunnings

2. Vernon works \textbf{for} Grunnings

   \textit{Beneficiary} \rightarrow \textit{OrgRole}

• Function \neq \text{Scene Role} in 1/3 of instances
Documentation

• Large number of labels, prepositions, constructions and ultimately languages → careful documentation is imperative

• Extensive guidelines
  • 450 examples
  • 80 pages

• Xposition: (under development)
  • A web-app and repository of prepositions/supersenses
  • Standardized format and querying tools to retrieve relevant examples/guidelines
Re-annotated Dataset

• STREUSLE is a corpus annotated with (preposition) supersenses
  • Text: review section of the English Web Treebank

• Complete revision of STREUSLE: version 4.0
  • [https://github.com/nert-gu/streusle/](https://github.com/nert-gu/streusle/)

• 5,455 target prepositions, including 1,104 possessives
  • 80:10:10% train:dev:test split

See Blodgett and Schneider, LREC 2018 for details
Preposition Distribution

• 249 prepositions
• 10 account for 2/3 of the mass
• 47 attested supersenses

• Frequencies:
  • 25% are spatial
  • 10% are temporal
  • 8% involve possession
Inter-Annotator Agreement

• Annotated a small sample of *The Little Prince*
  • 216 preposition tokens
  • 5 annotators, varied familiarity with scheme

• Exact agreement (pairwise avg.):
  74.4% on scene roles, 81.3% on functions
Disambiguation Models

1. Most Frequent (MF) baseline: most frequent label for the preposition in training
2. Neural: BiLSTM over sentence + multilayer perceptron per preposition
3. Feature-rich linear: SVM per preposition, with features based on previous work (Srikumar & Roth 2013)
   • Lexicon-based features: WordNet, Roget thesaurus

Use Universal Dependencies Syntax to detect governor and object
Target Identification

• Main challenges:
  • Multi-word prepositions, especially rare ones (e.g., “after the fashion of”)
  • Idiomatic PPs (e.g., “in action”, “by far”)

• Approach: rule-based

• Results:

<table>
<thead>
<tr>
<th></th>
<th>( F_1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold Syntax</td>
<td>89.2</td>
</tr>
<tr>
<td>Auto Syntax</td>
<td>85.9</td>
</tr>
</tbody>
</table>
Disambiguation Results

With gold standard syntax & target identification:

```
<table>
<thead>
<tr>
<th>Role Acc</th>
<th>Fxn Acc</th>
<th>Full Acc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most Frequent</td>
<td>Neural</td>
<td>Feature-rich linear</td>
</tr>
<tr>
<td>0</td>
<td>22.5</td>
<td>45</td>
</tr>
<tr>
<td>67.5</td>
<td>90</td>
<td>67.5</td>
</tr>
</tbody>
</table>
```
Results: Summary

• Predicting function label is more difficult than role label
  • ~8% gap in $F_1$ score in both settings

• This mirrors a similar effect in IAA, and is probably due to:
  • Less ambiguity in function labels (given a preposition)
  • The more literal nature of function labels

• Syntax plays an important role
  • 4-7% difference in performance
Results: Summary

• Neural and feature-rich approach are not far off in terms of performance
  • Feature-rich is marginally better
  • They agree on about 2/3 of cases; agreement area is 5% more accurate
Multi-Lingual Perspective

- Work is underway in Chinese, Korean, Hebrew and German

- Parallel Text: The Little Prince

- Challenges:
  - Complex interaction with morphology (e.g., via case)
  - How do prepositions change in translation?
  - How do role/function labels change in translation?
• A new approach to comprehensive analysis of the semantics of prepositions and possessives in English
  • Simpler and more concise than previous version
  • Good inter-annotator agreement
  • Extensive documentation
  • Encouraging initial disambiguation results
Ongoing Work

• Focus on:
  • Multi-lingual extensions to four languages
  • Streamlining the documentation and annotation processes
  • Semi-supervised and multi-lingual disambiguation systems
  • Integrating the scheme with a structural scheme (UCCA)
Acknowledgments

Discussion and Support
Oliver Richardson
Na-Rae Han
Archna Bhatia
Tim O’Gorman
Ken Litkowski
Bill Croft
Martha Palmer

Special Thanks
Noah Smith
Mark Steedman
Claire Bonial
Tim Baldwin
Miriam Butt
Chris Dyer
Ed Hovy
Lingpeng Kong
Lori Levin
Ken Litkowski
Orin Hargraves
Michael Ellsworth
Dipanjan Das & Google

CU annotators
Evan Coles-Harris
Audrey Farber
Nicole Gordiyenko
Megan Hutto
Celeste Smitz
Tim Watervoort

CMU pilot annotators
Archna Bhatia
Carlos Ramírez
Yulia Tsvetkov
Michael Mordowanec
Matt Gardner
Spencer Onuffer
Nora Kazour