Delexicalized Parsing

Daniel Zeman, Rudolf Rosa

March 31, 2022
• What if we feed the parser with tags instead of words?

  • Ændringer i listen i bilaget offentliggøres og meddeles på samme måde.
  • NNS IN NN IN NN VB CC VB IN DT NN
  • NNS IN NN MD VB CC VB IN DT NN
  • Förändringar i förteckningen skall offentliggöras och meddelas på samma sätt.
• What if we feed the parser with tags instead of words?

  • Ændringer i listen i bilaget offentliggøres og meddeles på samme måde.
  • ((NNS (IN NN (IN NN))) ((VB CC VB) (IN (DT NN))))
  • ((NNS (IN NN)) ((MD (VB CC VB)) (IN (DT NN))))
  • Förändringar i förteckningen skall offentliggöras och meddelas på samma sätt.
• Daniel Zeman, Philip Resnik (2008). Cross-Language Parser Adaptation between Related Languages
  • In *IJCNLP 2008 Workshop on NLP for Less Privileged Languages*, pp. 35–42, Hyderabad, India
Danish – Swedish Setup

  - In *IJCNLP 2008 Workshop on NLP for Less Privileged Languages*, pp. 35–42, Hyderabad, India

- CoNLL 2006 treebanks (*dependencies*)
  - Danish Dependency Treebank
  - Swedish Talbanken05

- Two *constituency* parsers:
  - “Charniak”
  - “Brown” (Charniak N-best parser + Johnson reranker)

- Other resources
  - (JRC-Acquis *parallel* corpus)
  - Hajič tagger for Swedish (*PAROLE* tagset)
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Treelbank Normalization

Danish

• DET governs ADJ
  ADJ governs NOUN

Swedish

• NOUN governs both DET and ADJ
Treebank Normalization

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• NUM governs NOUN

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• NOUN governs NUM
Treebank Normalization

Danish
- DET governs ADJ
- ADJ governs NOUN
- NUM governs NOUN
- GEN governs NOM

\textit{Ruslands vej}
\textit{Russia’s way}

Swedish
- NOUN governs both DET and ADJ
- NOUN governs NUM
- NOM governs GEN

\textit{årskomster}
\textit{year’s income}
Danish
- DET governs ADJ
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  *Ruslands vej*
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- COORD: last member on conjunction, everything else on first member

Swedish
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  *års inkomster*
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- COORD: member on previous member, commas and conjs on next member
• Transform Danish to Swedish tree style
  • A few heuristics
  • Only for evaluation! Not needed in real world.
Treebank Preparation

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- Convert dependencies to constituents
  - Flattest possible structure
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- derived from POS tags
- then translated to the Penn set of nonterminals
- Make the parser feel it works with the Penn Treebank (Although it could have been configured to use other sets of labels.)
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Unlabeled F Scores

• da-da lexicalized: Charniak = 78.16, Brown = 78.24
  • (CoNLL train 94K words, test 5852 words)
• sv-sv lexicalized: Charniak = 77.81, Brown = 78.74
  • (CoNLL train 191K words, test 5656 words)
• da-sv lexicalized: Charniak = 43.28, Brown = 41.84
  • (no morphology tweaking)
• da-da delexicalized: Charniak = 79.62, Brown = 80.20 (!)
  • (hybrid sv-da Hajič-like tagset = “words”, Penn POS = “tags”)
• sv-sv delexicalized: Charniak = 76.07, Brown = 77.01
• da-sv delexicalized: Charniak = 65.50, Brown = 66.40
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How Big Swedish Treebank Yields Similar Results?

Unlabeled $F_1$-score

![Graph showing the unlabeled $F_1$-score as a function of training sentences. The graph includes a data point at 66.40 with approximately 1546 sentences.]
Delexicalized Dependency Parsing

- Ryan McDonald, Slav Petrov, Keith Hall (2011). Multi-Source Transfer of Delexicalized Dependency Parsers
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- Google universal POS tags, two scenarios:
  - Gold-standard (just converted)
  - Projected across parallel corpus from English

"Danish is the worst possible source language for Swedish."


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- UAS (unlabeled attachment score)

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• No tree structure harmonization
  • “Danish is the worst possible source language for Swedish.”
## Multi-Source Transfer (McDonald et al., 2011)

<table>
<thead>
<tr>
<th>Target Test Language</th>
<th>Source Training Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>da</td>
<td>da</td>
</tr>
<tr>
<td>da</td>
<td><strong>79.2</strong></td>
</tr>
<tr>
<td>de</td>
<td>34.3</td>
</tr>
<tr>
<td>el</td>
<td>33.3</td>
</tr>
<tr>
<td>en</td>
<td>34.4</td>
</tr>
<tr>
<td>es</td>
<td>38.1</td>
</tr>
<tr>
<td>it</td>
<td>44.8</td>
</tr>
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<td>nl</td>
<td>38.7</td>
</tr>
<tr>
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<td>42.5</td>
</tr>
<tr>
<td>sv</td>
<td>44.5</td>
</tr>
</tbody>
</table>
Single-Source, Harmonized (DZ, summer 2015)

• Malt Parser, stack-lazy algorithm (nonprojective)
  • Same algorithm for all, no optimization
  • Same selection of training features for all treebanks

• Trained on the first 1000 sentences only
• Tested on the whole test set
• Default score: UAS (unlabeled attachment)
• Only harmonized data used (HamleDT 3.0 = UD v1 style)
• Single source language for every target
• Czech (62.44) $\leftarrow$ Croatian (63.27), Slovenian (62.87)
• Slovak (59.47) $\leftarrow$ Croatian (60.28), Slovenian (59.32)
• Polish (77.92) $\leftarrow$ Croatian (66.42), Slovenian (64.31)
• Russian (66.86) $\leftarrow$ Croatian (57.35), Slovak (55.01)
• Croatian (75.52) $\leftarrow$ Slovenian (58.96), Polish (55.42)
• Slovenian (76.17) $\leftarrow$ Croatian (62.92), Finnish (59.79)
• Bulgarian (78.44) $\leftarrow$ Croatian (74.39), Slovenian (71.52)
Who Helps Whom?

- Catalan (75.28) ⇐ Italian (71.07), French (68.30)
- Italian (76.66) ⇐ French (70.37), Catalan (68.66)
- French (69.93) ⇐ Spanish (64.28), Italian (63.33)
- Spanish (67.76) ⇐ French (67.61), Catalan (64.54)
- Portuguese (69.89) ⇐ Italian (69.48), French (66.12)
- Romanian (79.74) ⇐ Croatian (67.01), Latin (66.75)
Who Helps Whom?

- Swedish (75.73) ⇐ Danish (66.17), English (65.41)
- Danish (75.19) ⇐ Swedish (59.23), Croatian (56.89)
- English (72.68) ⇐ German (57.95), French (56.70)
- German (67.04) ⇐ Croatian (58.68), Swedish (57.48)
- Dutch (60.76) ⇐ Hungarian (41.90), Finnish (37.89)
How Big Swedish Treebank Yields Similar Results as Delex from Danish?

![Graph showing the relationship between training sentences and UAS score](image)

- **UAS**: 66.17
- **(delex)**
- **~ 75 sentences**
Multiple Source Treebanks

• So far: select one source at a time
  • How to select the best possible source?

  Alternative 1: train on all sources concatenated
    • Possibly with "weights" – take only part of a treebank, or take multiple copies of a treebank, or omit some treebanks

  Alternative 2: train on each source separately, then vote
    • Separate voting about every node's incoming edge
    • Weights – how much do we trust each source?

The result should be a tree!

Chu-Liu-Edmonds MST algorithm, as in graph-based parsing
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Syntactic Similarity of Languages

- Observation: We cannot compare trees!
  - In real-world applications, target trees will not be available

Language genealogy
- Targeting a Slavic language? Use Slavic sources!

Problem 1: What if no relative is available? (Buryat…)
- Problem 2: The important characteristics may differ significantly

English is isolating, rigid word order
- German uses morphology, freer but peculiar word order
- Icelandic has even more morphology

WALS features (recall the first week)
- Language recognition tool
  - But it relies on orthography!

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• Low-resource languages:
  • IE: Breton, Faroese, Naija, Upper Sorbian, Armenian, Kurmanji
  • Other: Kazakh, Buryat, Thai
Example: CoNLL 2018 Parsing Shared Task

- Low-resource languages:
  - IE: Breton, Faroese, Naija, Upper Sorbian, Armenian, Kurmanji
  - Other: Kazakh, Buryat, Thai

- High(er)-resource languages (selected groups only):
  - 1 Celtic (Irish)
  - 8 Germanic
  - 10 Slavic
  - 1 Iranian
  - 2 Turkic
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**Measuring Treebank Similarity: POS Tag N-grams**

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<th>de</th>
<th>it</th>
<th>cs</th>
</tr>
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<tbody>
<tr>
<td>DET ADJ NOUN</td>
<td>1.51</td>
<td>1.99</td>
<td>0.96</td>
<td>0.40</td>
</tr>
<tr>
<td>DET NOUN ADJ</td>
<td>0.05</td>
<td>0.26</td>
<td>1.77</td>
<td>0.10</td>
</tr>
<tr>
<td>#sent ADJ NOUN</td>
<td>0.13</td>
<td>0.09</td>
<td>0.02</td>
<td>0.52</td>
</tr>
<tr>
<td>NOUN PUNCT #sent</td>
<td>2.44</td>
<td>1.18</td>
<td>1.41</td>
<td>2.73</td>
</tr>
<tr>
<td>VERB PUNCT #sent</td>
<td>0.48</td>
<td>1.48</td>
<td>0.23</td>
<td>0.58</td>
</tr>
</tbody>
</table>
Kullback-Leibler Divergence

- $\textit{UPOS}$ ... universal set of 17 coarse-grained tags (from UD)
- $\textit{UPOS}' = \textit{UPOS} \cup \{\#\textit{sent}\}$ ... added sentence boundaries
- $(t_{i-2}, t_{i-1}, t_i)$ where $t_{i-2}, t_{i-1}, t_i \in \textit{UPOS}'$ ... trigram of tags at positions $i - 2$ ... $i$ of the corpus

$P_{\text{Corpus}}(x, y, z) = \frac{\text{count}_{\text{Corpus}}(x,y,z)}{\sum_{a,b,c} \text{count}_{\text{Corpus}}(a,b,c)}$

$D_{KL}(P_A || P_B) = \sum_{x,y,z} P_A(x,y,z) \cdot \log \frac{P_A(x,y,z)}{P_B(x,y,z)}$

$KL_{\text{cpos}^3}(\text{tgt, src}) = D_{KL}(P_{\text{tgt}} || P_{\text{src}})$

Asymmetric: amount of info lost when using the source distribution to approximate the true target distribution


In Proceedings of the 51st Annual Meeting of the Association for Computational Linguistics and the 7th International Joint Conference on Natural Language Processing, Short Papers.
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  - $x, y, z \in UPOS'$
  - Smoothing: need non-zero probability of every possible trigram

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Rudolf Rosa, Zdeněk Žabokrtský (2015). \( KL_{cpos}^{3}(\text{tgt}, \text{src}) = D_{KL}(P_{\text{tgt}}||P_{\text{src}}) \) – a Language Similarity Measure for Delexicalized Parser Transfer.

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- $D_{KL}(PA || PB) = \sum_{x, y, z} PA(x, y, z) \cdot \log \frac{PA(x, y, z)}{PB(x, y, z)}$
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  - Asymmetric: amount of info lost when using the source distribution to approximate the true target distribution
    - In *Proceedings of the 51st Annual Meeting of the Association for Computational Linguistics and the 7th International Joint Conference on Natural Language Processing, Short Papers*
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- Transition-based parsers rely on word order
  - en: the *following* question (features: s0=ADJ, b0=NOUN)
  - fr: la question *suivante* (features: s0=NOUN, b0=ADJ)
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    - Score them by target-language model
    - Take the best permutation

Delexicalized Parsing