FBK's Machine Translation Systems for IWSLT 2012's TED Lectures

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Roldano Cattoni, Marcello Federico
Outline

- Common components
- Arabic-English
- Turkish-English
- Dutch-English
- Conclusion
Fill-Up
(Bisazza et al., 2011; Nakov, 2008)
Cross-Entropy LM Filtering
(Moore & Lewis, 2010)

- Cross-Entropy ranking of sentences in a out-of-domain corpus against TED
- Incrementally add sentences to minimize perplexity on a development set
- Also applicable to parallel corpora by filtering on target language
Cross-Entropy LM Filtering (Moore & Lewis, 2010)

Cross-Entropy Filtering on English Corpora

Filtering tuned on TED dev2010 data
Outline

• Common features
• Arabic-English
• Turkish-English
• Dutch-English
• Conclusion
Arabic-English

- Early Distortion Cost
- Hybrid Language Modeling
- Phrase/Reordering Fill-Up (TED+MultiUN)
- Mixture LM (TED, Gigaword, WMT News)
Early Distortion Cost
(Moore & Quirk, 2007)

• Improved distortion penalty
• Anticipates gradual accumulation of total distortion cost
  – Incorporates an estimate of future jump's cost
  – Same distortion penalty as standard distortion cost over a complete hypothesis
• Benefits: Improves comparability of translation hypotheses with the same number of covered words
Early Distortion Cost
(Moore & Quirk, 2007)

\[ \text{Tot(std)} = 12 \]
\[ \text{Tot(edc)} = 12 \]
# Early Distortion Cost

(Moore & Quirk, 2007)

<table>
<thead>
<tr>
<th>DL</th>
<th>DC</th>
<th>tst2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>std</td>
<td>26.12/6.514</td>
</tr>
<tr>
<td>8</td>
<td>std</td>
<td>25.95/6.460</td>
</tr>
<tr>
<td>8</td>
<td>edc</td>
<td>26.31/6.551</td>
</tr>
</tbody>
</table>

Hong Kong, 6 December 2012

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Hybrid Language Modeling  
(Bisazza & Federico, 2011)

- Replace bottom 25% of tokens with POS tags – corresponds to 2% of types

In-domain target data

Now you laugh, but that quote has kind of a sting to it, right. And I think the reason it has…

Now you VB, but that NN has kind of a NN to it, right. And I think the reason it has…

…a sting is because thousands of years of history don’t reverse themselves without a lot of pain.

…a NN is because NNS of years of history don’t VB PP without a lot of NN.

Hybridly mapped word/POS data

- Allows for the construction of 10-gram LMs
# Arabic-English results

<table>
<thead>
<tr>
<th></th>
<th>LM</th>
<th>DL</th>
<th>tst2011</th>
<th>tst2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>MixAll.4g +TED.Hybrid10g</td>
<td>8 edc</td>
<td>25.46/6.232</td>
<td>27.86/6.881</td>
</tr>
<tr>
<td>C₁</td>
<td>MixAll.4g +TED.Hybrid10g</td>
<td>8 edc</td>
<td>25.19/6.205</td>
<td>27.74/6.903</td>
</tr>
<tr>
<td>C₂</td>
<td>MixFiltered.5g +TED.Hybrid10g</td>
<td>8 edc</td>
<td>25.13/6.190</td>
<td>27.54/6.828</td>
</tr>
</tbody>
</table>
Outline

- Common features
- Arabic-English
- Turkish-English
- Dutch-English
- Conclusion
Turkish-English

- Morphological Segmentation
- Hierarchical phrase-based decoding
- Mixture LM
Morphological Splitting

- Rule-based vs. Unsupervised segmentation

<table>
<thead>
<tr>
<th>Distortion Limit</th>
<th>Distortion Calc</th>
<th>Seg</th>
<th>tst2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>std</td>
<td>MS6</td>
<td>13.61/5.280</td>
</tr>
<tr>
<td>15</td>
<td>std</td>
<td>MS15</td>
<td>14.38/5.273</td>
</tr>
<tr>
<td>15</td>
<td>std</td>
<td>Morfessor</td>
<td>13.45/5.080</td>
</tr>
</tbody>
</table>

- MS6: Nominal suffixes (case + possessive) only
- MS15: Nominal and verbal suffixes
  - e.g. person-subject, negation, passive, etc.
- Morfessor:
  - Concatenates non-initial “morphs” into word endings
  - Could perhaps be trained with better configurations
Morphological Splitting

Original: Kendisine Don diyelim.

Analyzed:
- Kendi + Pron + Reflex + A3sg + P3sg + Dat
- Don + Noun + A3sg + Pnon + Nom
- De + Verb + Pos + Opt + A1pl

MS15:
- Kendi + Pron + Reflex + A3sg
- Don + Noun + A3sg
- De + Verb + Opt

Morfessor:
- Kendi + sine
- Don
- diyelim

Trans: Let 's call him Don.
Hierarchical Phrase-Based Decoding

- Better able to handle mismatches in predicate-argument structure between languages
- Robust with respect to long-distance reordering

<table>
<thead>
<tr>
<th>Turkish (source)</th>
<th>English (target)</th>
<th>Rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>[X] söyle+Verb+Fut</td>
<td>will say [X]</td>
<td>SOV → SVO</td>
</tr>
<tr>
<td>[X] +Dat bak</td>
<td>look at [X]</td>
<td>S Comp V → S V Comp</td>
</tr>
<tr>
<td>[X] +Dat baktı</td>
<td>looked at [X]</td>
<td>S Comp V → S V Comp</td>
</tr>
</tbody>
</table>
Turkish-English results

<table>
<thead>
<tr>
<th>System</th>
<th>Seg</th>
<th>tst2011</th>
<th>tst2012</th>
</tr>
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<tbody>
<tr>
<td>P</td>
<td>Hierarchical</td>
<td>MS15</td>
<td>17.24/5.560</td>
</tr>
<tr>
<td>$C_1$</td>
<td>Phrase-based (dl=15, edc)</td>
<td>MS15</td>
<td>15.45/5.289</td>
</tr>
</tbody>
</table>
Outline

- Common features
- Arabic-English
- Turkish-English
- Dutch-English
- Conclusion
Dutch-English

• Language properties
  – Similar to German
    • SVO for main clauses, SOV for subordinates
    • Noun casing, but less than German
  – Only “gendered” and “neutered” nouns/determiners
  – Compound nouns and verbs
Dutch-English

- Compound Splitting
- Phrase/Reordering Fill-Up (TED+Europarl)
- Mixture LM
Compound Splitting
(Koehn & Knight, 2003)

- Preliminary experiments on German, carried over to Dutch

- Moses Compound Splitting tool
  - Split candidate words into tokens already existing in a corpus' vocabulary
  - Default (normal) setting: min 4 characters per split
  - Aggressive setting: reduce minimum to 2 chars
    - e.g. “aanvragen”, “afvallen”
He said he didn't know. He would ask around.

Hij zei dat hij het niet wist. Hij zou rondvragen

(Normal/Aggressive splitting)

And he said that he did not know. He would ask around.
Compound Splitting

Not by the latest combine and tractor invention

niet door de laatste combine- en tractoruitvinding

(Normal splitting) tractor uitvinding invention

(Aggressive splitting) uit vin ding from vin thing
## Dutch-English results

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<tr>
<th>Splitter</th>
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</tr>
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<tbody>
<tr>
<td>P Normal</td>
<td>36.11/7.921</td>
<td>32.68/7.743</td>
</tr>
<tr>
<td>C₁ Normal</td>
<td>36.23/7.946</td>
<td>32.48/7.722</td>
</tr>
<tr>
<td>C₂ Aggressive</td>
<td>35.82/7.881</td>
<td>32.68/7.725</td>
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- **P**: 4-gram Mix LM
- **C₁**: 5-gram Mix LM
- **C₂**: 6-gram Mix LM
### Dutch-English results

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- **P**: 4-gram Mix LM
- **C₁**: 5-gram Mix LM
- **C₂**: 6-gram Mix LM
Conclusion

• We present several ideas for Arabic-, Turkish-, and Dutch-English machine translation

• Contributions:
  – Early distortion limit (Arabic, attempted w/ Turkish)
  – Morphological Segmentation (Turkish)
  – Compound Splitting (Dutch)
  – Corpora Filtering