The NAIST Machine Translation System for IWSLT 2012

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Overview

- Phrase-based machine translation
- Built on Moses (experiment management system)
- Evaluated on TED Translation:
  - English → French official track
  - XXX → English other tracks

Focus:
- easily implementable
- language-independent methods
English-French
Summary of English-French

- Four successful statistical methods:
  - Phrase-table smoothing
  - Language model interpolation
  - Calibrated minimum Bayes risk decoding
  - Large-scale data with filtering
- Combination raises BLEU 29.75 → 31.81
- Ablation tests to examine the factors
Phrase Table Smoothing

- Phrase probabilities for rare phrases over-fit the training data
- Smoothing discounts observed counts when calculating probabilities
- Here we test Good-Turing smoothing [Foster 06]
Smoothing Results

- dev2010: +0.30
- tst2010: +0.62

Legend:
- No Smoothing
- Good-Turing
Language Model Interpolation

- LM data from heterogeneous sources
  - TED, News Commentary, Europarl, Giga
- Combine using simple linear interpolation
- Maximize likelihood of development set [Jelinek 80]
Language Model Interpolation Results

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<table>
<thead>
<tr>
<th></th>
<th>dev2010</th>
<th>tst2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>TED Only</td>
<td>+1.50</td>
<td>+1.71</td>
</tr>
<tr>
<td>Without Interp</td>
<td>+2.25</td>
<td>+2.37</td>
</tr>
<tr>
<td>With Interp</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Minimum Bayes Risk Decoding

- **Normal Decoding**: Choose the translation with highest probability
- **MBR Decoding**: From an n-best list, choose the translation with the lowest expected loss [Kumar 04]
- **Lattice MBR Decoding**: MBR over lattices [Tromble 08]
- Also tested **calibrating** the probability distribution
Minimum Bayes Risk Results

- dev2010:
  - No MBR: -0.30
  - MBR: -0.89
  - Lattice MBR: -0.54
  - + Calibration: +0.23

- tst2010:
  - No MBR: -0.30
  - MBR: -0.89
  - Lattice MBR: -0.54
  - + Calibration: +0.80
Large-Scale Data with Filtering

- Giga-word English-French corpus is large, but noisy
- Train a classifier to detect noisy sentences
  - Features: Model 1, Alignment, Length Ratio, Same Word
- Use pseudo-negative training examples by swapping 30% of sentences [Mediani 2011]

\[
\begin{array}{c|c}
F_1 & E_1 \\
F_2 & E_2 \\
F_3 & E_3 \\
F_4 & E_4 \\
\end{array} \quad \begin{array}{c|c}
F_1 & E_1 \\
F_3 & E_2 \\
F_2 & E_3 \\
F_4 & E_4 \\
\end{array}
\]

\[
\begin{array}{c}
-1 & +1 \\
-1 & +1 \\
+1 & -1 \\
+1 & -1 \\
\end{array}
\]
Data Filtering Results

![Diagram showing BLEU scores for dev2010 and tst2010 datasets with different data filtering results.]

- **TED+NC+EP**
- **+Unfiltered GIGA**
- **+Filtered GIGA**

**dev2010**:
- TED+NC+EP: 26.25
- +Unfiltered GIGA: 26.65
- +Filtered GIGA: 27.07

**tst2010**:
- TED+NC+EP: 26.25
- +Unfiltered GIGA: 30.42
- +Filtered GIGA: 31.53

**Changes**:
- +Unfiltered GIGA: +0.42
- +Filtered GIGA: +0.38
Other Methods Investigated

- Out of domain TM data
- Word alignment methods + combination
- Lexical reordering models
- MERT vs. PRO tuning

See the paper for more details!
XXX-English Language Pairs
Linguistic Family Tree

- **Indo-European** Family:
  - **Germantic**: German (de), Dutch (nl), English (en)
  - **Italic**: Portuguese (pt), Romanian (ro)
  - **Slavic**: Polish (pl), Russian (ru), Slovak (sk)
- **Afro-Asiatic** Family: Arabic (ar)
- **Altaic** Family: Turkish (tr)
MT Issues

- **Morphology:**
  - pl/ru/sk (fusional)
  - tr (agglutinative)
  - de/nl (compounding)
  - pt/ro (some inflection)

- **Word order:**
  - de/nl (SOV, V2)
  - ar (VSO)
Summary of XXX-English Systems

- **Common EMS setup:** compare performance of existing techniques cross-linguistically
- **What worked generally:**
  - Unsupervised Morphology
    - Using Morfessor and compound-splitter.perl
  - Gigaword LM
Unsupervised Morphology

- **Compound-splitter.perl [Koehn 03]**
  - Breaks apart words if subparts are seen in training data over a certain frequency

- **Morfessor 1.0 [Creutz 02]**
  - Use Minimum Description Length principle to find a small set of morphemes that covers the training words
  - Discovers both free & bound morphemes
  - Small modification: Morfessor segments too aggressively for unknown words, so keep OOV as is
Vocabulary Growth Rate

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Morphology Results

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Gain in BLEU

<table>
<thead>
<tr>
<th>Language</th>
<th>Compound Split</th>
<th>Morfessor</th>
</tr>
</thead>
<tbody>
<tr>
<td>ar</td>
<td>+1.5</td>
<td></td>
</tr>
<tr>
<td>de</td>
<td></td>
<td>+0.5</td>
</tr>
<tr>
<td>nl</td>
<td>+0.2</td>
<td></td>
</tr>
<tr>
<td>pl</td>
<td>+0.2</td>
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<tr>
<td>pt</td>
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<td>+0.2</td>
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<td>ro</td>
<td></td>
<td>+0.3</td>
</tr>
<tr>
<td>ru</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tr</td>
<td></td>
<td>+1.0</td>
</tr>
</tbody>
</table>
Language Model Addition

- Added additional Giga-Word language model
Other Methods Investigated

- Out of domain TM data
- Lattice-based MBR

See the paper for more details!
Thank You!