Phrase Reordering for Statistical Machine Translation Based on Predicate-Argument Structure

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Overview of NAIST-NTT System

- Improve translation model by phrase reordering

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Motivation

- Translation model using syntactic and semantic information has not yet succeeded
  
  Improve statistical machine translation by using predicate-argument structure

- Improve distortion model between language pairs with different word orders
  
  Improve word alignment by phrase reordering
Outline

• Overview
• Phrase Reordering by Predicate-argument Structure
• Experiments and Results
• Discussions
• Conclusions
• Future Work
Phrase Reordering by Predicate-argument Structure

- Phrase reordering by morphological analysis (Niessen and Ney, 2001)
- Phrase reordering by parsing (Collins et al., 2005)
Predicate-argument Structure Analyzer: SynCha

- Predicate-argument structure analyzer based on (Iida et al., 2006) and (Komachi et al., 2006)
  - Identify predicates (verb/adjective/event-denoting noun) and their arguments
  - Can cope with zero-anaphora and ellipsis
- Achieves F-score 0.8 for arguments within a sentence
Predicate-argument Structure Analysis Steps

住所 を ここ に 書いて 下さい て

- address-ACC
- here-LOC
- write
- please
Phrase Reordering Steps

- Find predicates (verb/adjective/event-denoting noun)
- Use heuristics to match English word order
Preprocessing

• Japanese side
  • Morphological analyzer/Tokenizer: ChaSen
  • Dependency parser: CaboCha
  • Predicate-argument structure: SynCha

• English side
  • Tokenizer: tokenizer.sed (LDC)
  • Morphological analyzer: MXPOST
  • All English words were lowercased for training
Aligning Training Corpus

• Manually aligned 45,909 sentence pairs out of 39,953 conversations

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sure. please fill out this form.

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sure.

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### Training Corpus Statistics

<table>
<thead>
<tr>
<th></th>
<th># of sent.</th>
<th></th>
<th># of sent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve alignment</td>
<td>33,874</td>
<td>Reordered</td>
<td>18,539</td>
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<tr>
<td>Degrade alignment</td>
<td>7,959</td>
<td>Contain crossing</td>
<td>39,979</td>
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<tr>
<td>No change</td>
<td>4,076</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>45,909</strong></td>
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<td></td>
</tr>
</tbody>
</table>

Add each pair to training corpus

Learn word alignment by GIZA++

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this form-LOC write please
Experiments

• WMT 2006 shared task baseline system trained on normal order corpus with default parameters
• Baseline system trained on pre-processed corpus with default parameters
• Baseline system trained on pre-processed corpus with parameter optimization by a minimum error rate training tool (Venugopal, 2005)
Translation Model and Language Model

- Translation model
  - GIZA++ (Och and Ney, 2003)
- Language model
  - Back-off word trigram model trained by Palmkit (Ito, 2002)
- Decoder
  - WMT 2006 shared task baseline system (Pharaoh)
Minimum Error Rate Training (MERT)

• Optimize translation parameters for Pharaoh decoder
  • Phrase translation probability (JE/EJ)
  • Lexical translation probability (JE/EJ)
  • Phrase penalty
  • Phrase distortion probability

• Trained with 500 normal order sentences
## Results

<table>
<thead>
<tr>
<th>ASR 1-BEST</th>
<th>System</th>
<th>BLEU</th>
<th>NIST</th>
</tr>
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<tbody>
<tr>
<td>Baseline</td>
<td>0.1081</td>
<td>4.3555</td>
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<tr>
<td>Proposed (w/o MERT)</td>
<td>0.1366</td>
<td>4.8438</td>
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<td>Proposed (w/ MERT)</td>
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<td>4.8372</td>
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</table>

<table>
<thead>
<tr>
<th>Correct recognition</th>
<th>System</th>
<th>BLEU</th>
<th>NIST</th>
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</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0.1170</td>
<td>4.7078</td>
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<tr>
<td>Proposed (w/o MERT)</td>
<td>0.1459</td>
<td>5.3649</td>
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</tr>
<tr>
<td>Proposed (w/ MERT)</td>
<td>0.1431</td>
<td>5.2105</td>
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</table>
Results for the Evaluation Campaign

• While it had high accuracy on translation of content words, it had poor results on individual word translation
  • ASR: BLEU 12/14, NIST 11/14, METEOR 6/14
  • Correct Recognition: BLEU 12/14, NIST 10/14, METEOR 7/14
• Pretty high WER
Discussion

• Better accuracy over the baseline system
  • Improve translation model by phase reordering
• Degrade accuracy by MERT
  • Could not find a reason yet
  • Could be explained by the fact that we did not put any constraints on reordered sentences (They may be ungrammatical on Japanese side)
• Predicate-argument structure accuracy
  • SynCha is trained on newswire sources (not optimized for travel conversation)
Discussion (Cont.)

- Phrase alignment got worse by splitting a case marker from its dependent verb

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Conclusions

• Present phrase reordering model based on predicate-argument structure

• The phrase reordering model improved translation accuracy over the baseline method
Future work

• Investigate the reason why MERT does not work
  • Make reordered corpus more grammatical (reorder only arguments)
• Use newswire sources to see the effect of correct predicate-argument structure
• Reorder sentences which have crossing alignments only
• Use verb clustering and map arguments automatically