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
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
  - Trained on NAIST Text Corpus
    http://cl.naist.jp/nldata/corpus/
  - 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 て 下さい
address-ACC here -LOC write please

WO-ACC
NI-LOC
predicate
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

かしこまりました。この用紙に記入して下さい。

sure. please fill out this form.

かしこまりました。

sure.

この用紙に記入して下さい。

please fill out this form.
## Training Corpus Statistics

|                      | # of sent. |
|----------------------|------------|
| Improve alignment    | 33,874     |
| Degrade alignment    | 7,959      |
| No change            | 4,076      |
| Total                | 45,909     |

|                      | # of sent. |
|----------------------|------------|
| Reordered            | 18,539     |
| Contain crossing     | 39,979     |

Add each pair to training corpus

Learn word alignment by GIZA++
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

| ASR 1-BEST                    | System           | BLEU   | NIST   |
|-------------------------------|------------------|--------|--------|
| Baseline                      |                  | 0.1081 | 4.3555 |
| Proposed (w/o MERT)           |                  | 0.1366 | 4.8438 |
| Proposed (w/ MERT)            |                  | 0.1311 | 4.8372 |

| Correct recognition           | System           | BLEU   | NIST   |
|-------------------------------|------------------|--------|--------|
| Baseline                      |                  | 0.1170 | 4.7078 |
| Proposed (w/o MERT)           |                  | 0.1459 | 5.3649 |
| Proposed (w/ MERT)            |                  | 0.1431 | 5.2105 |
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

住所 を
address-ACC
ここ に
here-LOC
書いて 下さい
write please

書いて 下さい
write please
住所 を
address-ACC
ここ に
here-LOC
please write down your address here
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