The ITC-irst Statistical Machine Translation System
for IWSLT-2004

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ITC-irst

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Outline

- The ITC-irst SMT System
  - Log-linear Model
  - Phrase-based Model
  - Decoding
  - System Architecture

- Experiments for IWSLT-2004
  - Selection of Training Data
  - Chinese Segmentation
  - Official Results
Log-linear model for SMT

Maximum Entropy framework for word-alignment MT approach:

\[ e^* = \arg \max_e \sum_a \Pr(e, a \mid f) \approx \arg \max_e \max_a \Pr(e, a \mid f) \quad (1) \]

\( \Pr(e, a \mid f) \) is determined through real valued feature functions \( h_i(e, f, a), i = 1 \ldots M \), and takes the parametric form:

\[ p_\lambda(e, a \mid f) = \frac{\exp\{\sum_i \lambda_i h_i(e, f, a)\}}{\sum_{e,a} \exp\{\sum_i \lambda_i h_i(e, f, a)\}} \quad (2) \]

Example: feature functions of IBM Model 4:

\[ h_1(e, f, a) = \log \Pr(e) \quad \text{(target language model)} \]
\[ h_2(e, f, a) = \log \Pr(\phi \mid e) \quad \text{(fertility model)} \]
\[ h_3(e, f, a) = \log \Pr(\tau \mid e, \phi) \quad \text{(lexicon model)} \]
\[ h_4(e, f, a) = \log \Pr(\pi \mid e, \phi, \tau) \quad \text{(distortion model)} \]
Phrase-based model

- A phrase is a sequence of one or more words (no semantic or syntactic meaning)
- One-to-one correspondence between phrases
- Source words may be not translated (into $\tilde{e}_0$)
- Insertion of target phrases without translation
- All models at phrase level except language model (at word level)
- Frequency-based distributions
- Statistics collected from a word alignment (e.g. produced by GIZA++)
Decoding

- approximate search criterion: \( \tilde{e}^* \approx \arg \max_{\tilde{e}} \max_a \sum_i \lambda_i h_i(\tilde{e}, f, a) \}

- DP-based algorithm

- search progresses synchronously along the target string (decisions are taken when generating target phrase)

- search ends when all source positions are covered

- optimal final theory is chosen among all complete theories

- beam search: threshold pruning, histogram pruning

- garbaging of theories without extensions

- constraints on the length of the source and target phrases
System Architecture: Run-Time

MODEL PARAMETERS
- lexicon distributions
- fertility
- distortion
- LM
- scaling factors

Preprocessing → PREPROCESSED

Decoder → BEST HYPOTHESIS

BEST TRANSLATION

Postprocessing
System Architecture: Training

Phase 1: Phrase-based Model Training

Phase 2: Minimum Error Training

PREPROCESSED TRAINING SET

Word Aligner

PHRASE-BASED MODEL PARAMETERS
- lexicon distributions
- fertility
- distortion
- LM

Parameter Estimation

PHRASES

DECODER

TRANSLATION

SCALING FACTORS
- λ1
- ...
- λ6

Evaluator

Simplex

SCORE

PREPROCESSED DEVELOPMENT SET
Experiments

- Chinese-English track (all the three data conditions)
- no optimization on the post-processing
- BLEU score for data selection and minimum error training
Preprocessing

- tokenization (EN)*
- dp-based Chinese segmentation (CH)*
- rule-based recognition of time and numerical expressions (CH, EN): weekdays, month names, percentages, cardinals, ordinals
- lower case text (EN)
- ignored unknown Chinese words
- split of long sentences (test)

* when needed
## Selection of Training Data

<table>
<thead>
<tr>
<th>System name</th>
<th>extra data</th>
<th>BLEU</th>
<th>NIST</th>
<th>MWER</th>
<th>MPER</th>
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</table>

- DB1: news corpora
- DB2: press releases of Hong Kong Special Administrative Region
- DB3: selection of corpora from NIST MT-EVAL 2004 competition (large data condition)
Chinese Segmentation

1. Supplied:
   - Chinese segmentation as provided in the supplied training/test corpora

2. Special:
   - Chinese segmentation from scratch
   - word-frequency list (7K) extracted from the supplied training corpus

3. Full:
   - Chinese segmentation from scratch
   - word-frequency list (44K) provided by LDC
## Official Results: Objective Scores

<table>
<thead>
<tr>
<th>Data Condition</th>
<th>Segmentation</th>
<th>BLEU</th>
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(∗) marked for subjective evaluation
## Official Results: Subjective Scores

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<th>Data Condition</th>
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<th>Fluency</th>
<th>Adequacy</th>
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THE END
ITC-irst SMT System

Decoding: Expansion, Recombination and Pruning

Direction of Expansion

Hash Table

Initial Theory

Past Best

Current Best

Complete Theory

Pruned Theory

Active Theory

Optimal Theory

Final Theory