The TALP Ngram-based SMT System for IWSLT 2007

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IWSLT 2007, Trento
1. TALP Ngram-based Translation System
2. Alignment Minimum Translation-Error Training
3. Simultaneous Perturbation Stochastic Approximation method
4. Word ordering strategies
5. Neural Network Language Model
6. Experiments
7. Conclusions and Further Work
1. TALP Ngram-based Translation System
   - Translation Model
   - Additional Feature Functions

2. Alignment Minimum Translation-Error Training

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7. Conclusions and Further Work
The best translation hypothesis $T$, for a given source sentence $S$, is that which maximizes a log-linear combination of feature functions:

$$
\hat{T} = \arg \max_T \sum_m \lambda_m h_m(T, S)
$$

- Translation Model:
  - N-gram language model of bilingual units (tuples)
    
    $$
    p(T, S) \approx \prod_n p((t, s)_n | (t, s)_{n-N+1}, \ldots, (t, s)_{n-1})
    $$

Tuple extraction

Tuples are extracted from word alignment

- A unique and monotonic segmentation of each sentence is produced.
- No word in a tuple is aligned to words outside of it
- No smaller tuples can be extracted without violating the previous constraints
Tuple extraction example

Unfolding produces a different bilingual n-gram model with reordered source words.
Additional feature functions:

- Target language model
- POS target language model
- Word bonus model, giving a bonus proportional to the number of target words.
- Source-to-target and target-to-source lexicon models, which compute a lexical weight for each tuple, using IBM model 1 translation probabilities
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Alignment Minimum Translation-Error Training

Our Method
Tuning alignment parameters directly in a Minimum translation Error Training scheme: use automated translation metrics as minimization criterion.

Alignment optimization parameters chosen for GIZA++:
- Smoothing factors for models HMM, IBM3 and IBM4
- The probability for the empty word
- Deficient distortion for the empty word
Procedure

- Optimal coefficients were estimated with the following procedure:
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- SMT system with TM model (bilingual language model)
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Simultaneous Perturbation Stochastic Approximation

- The SPSA method [J. Spall, 1992] is based on a gradient approximation which requires only two evaluations of the objective function, regardless of the dimension of the optimisation problem.
- SPSA procedure is in the general recursive stochastic approximation form:

\[
\hat{\lambda}_{k+1} = \hat{\lambda}_k - a_k \hat{\mathbf{g}}_k(\hat{\lambda}_k)
\]

\(\hat{\mathbf{g}}_k(\hat{\lambda}_k)\): estimate of the gradient \(\mathbf{g}(\lambda) \equiv \partial E / \partial \lambda\) at iterate \(k\)
The simultaneous approximation causes deviations of the search path. These deviations are averaged out in reaching a solution.
## Optimization schemes

<table>
<thead>
<tr>
<th>Concept</th>
<th>Procedure</th>
<th>Optimized parameters</th>
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<td>Nbest-list produced by the decoder</td>
<td>(Double-loop) Minimum Error Training</td>
<td>Translation feature functions</td>
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TALP (UPC) - The TALP Ngram-based SMT System for IWSLT 2007
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4. **Word ordering strategies**

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Reordering patterns

Use a set of rewrite rules for Part-Of-Speech sequences to extend the monotonic search graph with reordering hypotheses
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The basic idea of the neural network LM is to project the word indexes onto a continuous space and to use a probability estimator operating on this space.

- The resulting probability functions are smooth functions of the word representation → better generalization to unknown $n$-grams can be expected.
- A neural network → simultaneously learns the projection of the words onto the continuous space and estimates the $n$-gram probabilities.
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- The resulting probability functions are smooth functions of the word representation → better generalization to unknown $n$-grams can be expected.
- A neural network → simultaneously learns the projection of the words onto the continuous space and estimates the $n$-gram probabilities.

The LM posterior probabilities are “interpolated” for any possible context of length $n-1$ instead of backing-off to shorter contexts.
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6. **Experiments**
   - Description
   - Results

7. Conclusions and Further Work
Data Preprocessing

- Training sentences were split by using final dots on the bilingual text
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- **Arabic**
  - MADA+TOKAN system for disambiguation and tokenization.
  - This tool produces POS tags on all taggable tokens.
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- **English**
  - Part-Of-Speech tagging \( TnT \) tagger.
  - For alignment purpose only (of the ZhEn system), the Snowball stemmer.
Experimental Settings

- **Alignment parameters**
  - running 5, 5, 3 and 3 iterations of models 1, HMM, 3 and 4,
  - using English stems and 50 classes,
  - taking the union of source-target and target-source alignments.

- **Decoding parameters**
  - the beam search was set to 50,
  - no reordering limit in search (all paths present in the input reordering graph are considered).

- **Rescoring**
  - incorporation of the NNLM into the SMT system was done using 1000-best lists.
Table: Internal translation results for IWSLT 2007 Chinese-English task. MET refers to alignment tuning with Minimum (translation) Error Training. NNLM refers to rescoring a translation N-best list with a continuous space target language model.
Participation in the IWSLT 2007 Evaluation

<table>
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<tr>
<th>System</th>
<th>UPC</th>
<th>Best</th>
<th>Rank</th>
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</thead>
<tbody>
<tr>
<td>AE ASR Primary</td>
<td>0.4445</td>
<td>0.4445</td>
<td>1/11</td>
</tr>
<tr>
<td>AE Clean Primary</td>
<td>0.4804</td>
<td>0.4923</td>
<td>3/11</td>
</tr>
<tr>
<td>CE Clean Primary</td>
<td>0.2991</td>
<td>0.4077</td>
<td>11/15</td>
</tr>
<tr>
<td>CE Clean Primary + NNLM</td>
<td>0.2920</td>
<td>0.4077</td>
<td></td>
</tr>
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</table>

Table: Official translation results (BLEU scores) for IWSLT 2007 Chinese-English and Arabic-English tasks. Next to our system’s score, we indicated the Best system’s score. For the primary runs, we also indicated the rank of our system among all primary runs.
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Conclusions and further work

The optimization of alignment parameters allows to improve translation when using the Alignment Minimum Translation-Error Training.
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2. The NNLM obtained an improvement of 1.5 Bleu in the internal set.
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1. The optimization of alignment parameters allows to improve translation when using the Alignment Minimum Translation-Error Training.

2. The NNLM obtained an improvement of 1.5 Bleu in the internal set.

3. Our system was ranked 1st in the Arabic-English task. It was not very competitive in the Chinese-English task.
Thanks

Grazie a tutti

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