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Prosodic annotation enriched statistical machine translation

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OUTLINE

- Introduction
- Methods
- Experiments
- Conclusion

INTRODUCTION

- Prosodic features
  - Continuous prosodic features

    Duration time, speaking rate, fundamental frequencies ,energy
  - Discrete prosodic annotations

    Boundaries, emphasis, pronunciation, tone
- Statistical machine translation (SMT) with prosodic features
  - Use energy, duration and F0 for speed-up parsing and translation[1]
  - Prosody enriched factored translation model[2]
  - Rule extraction according to prosodic boundaries[3]

INTRODUCTION

- Challenge
  - Conventional approaches ignore the key information beyond the text
- Prosodic features in our machine translation system
  - Improve source language analysis in Chinese-English translation
    - Factored models, word lattices with prosody
  - Help target language generation in English-Chinese translation
    - Re-ranking model

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METHODS

- Basic Assumption
  I. The translations of some words rely on their prosodic features
  II. Normal Chinese sentences have reasonable prosodic structures
- Prosodic features we used:
  - Pronunciation

    The phonetic alphabet and the tone
  - Prosody boundaries

    Boundaries of sentences, phrases and prosodic words
  - Emphasis

    Emphasis of sentences and of phrases

METHODS

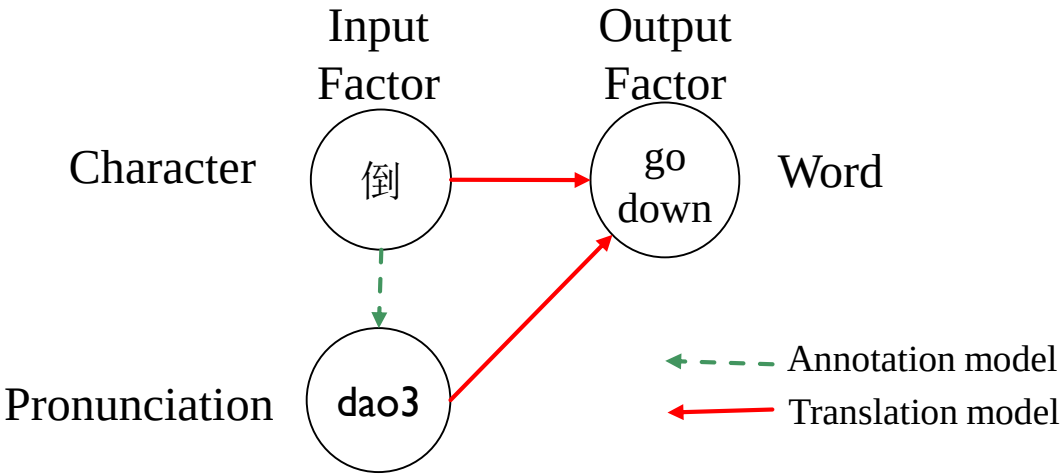
- Features used in our CRF prosody tagger

Type	Features
Character Feature	character(i) (i=-2,-1,0,+1,+2)
Pronunciation Feature	pronunciation(0)
Composite Feature	character(-2,-1,0)
	character(0,1,2)
	pronunciation(-2,-1,0)
	pronunciation(0,1,2)

METHODS

- Factored translation model with prosody

[SRC]上|shang4 周|zhou1 日|ri4 台|tai2 风|feng1 , **倒|dao3** 了|le5 一|yi4 棵|ke1 木|mu4 瓜|gua1 树|shu4
[REF]A papaya tree **went down** in the typhoon last Sunday
[RES]There is a typhoon on Sunday, **pour** a papaya tree



METHODS

- Factored translation models with prosody
  - Chinese-English (C2E) translation

$$h_{T,C2E}(e,f) = \lambda_0 \log P(f|e) + \sum_{i=1}^{3} \lambda_i \log P(f|f_i) P(f_i|e)$$

$$\approx \lambda_0 \log P(f|e) + \sum_{i=1}^{3} \lambda_i \log P(f_i'|e)$$

Annotation model for prosodic annotations

Translation model for prosodic factors

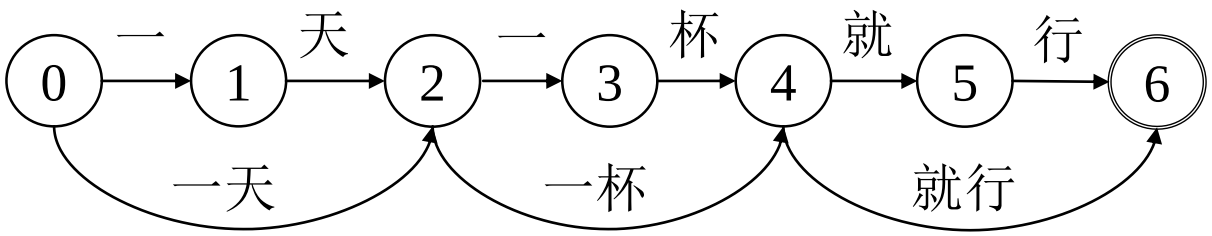
  - English-Chinese (E2C) translation

$$h_{T,E2C}(e,f) = \lambda_0 \log P(f|e) + \sum_{i=1}^{3} \lambda_i \log P(f|e_i) P(e_i|e)$$

Generation step for prosodic factors

METHODS

- Word lattice with prosodic boundaries
  - Take full advantages of the prosodic structures
  - Expand the space of translation candidates



METHODS

- Re-ranking with language model of prosodic tags
  - Target language probabilities interpolated with prosodic features:

$$P'(e) = \frac{1}{Z}\exp\left(\alpha_0 \log P(e_0) + \sum_{i=1}^{3} \alpha_i \log P(e_i)\right)$$

  - Re-ranking score for n-best lists:

$$Score(e|f) = Score'(e|f) + \frac{1}{Z}\exp\left(\sum_{i=1}^{3} \alpha_i \log P(e_i)\right)$$

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EXPERIMENTS

- Corpus
  - DISCOURSE-CASS (prosodic corpus) :
    - 244 audio files (12 hours, 8 kHz sampling rate)
    - Domains: insurance, bank, China Telecom, China Unicom and QQ chat
    - Provided by Phonetics and Speech lab, Institute of Linguistics, CASS
  - BOLT (parallel corpus):
    - Chinese-English parallel corpus of chat messages
    - Training(150,123 sentence pairs), development (4,932 sentence pairs) ,testing (4,977 sentence pairs)
    - Provided by LDC

EXPERIMENTS

- Baseline System
  - Moses for training and decoding
  - GIZA++ with sL0 norm For Alignment
  - SRILM for language model
  - MERT for tuning parameters
  - BLEU for evaluation (Character-level computation for Chinese)
- CRF prosody tagger
  - Accuracy for prosodic boundaries prediction: 69.66%
  - Accuracy for emphasis annotations prediction: 62.02%

EXPERIMENTS

- Results of the factored models with prosody
  - Character(Char)
  - Pronunciation(Pron)
  - Boundaries(Boun)
  - Emphasis(Emph)

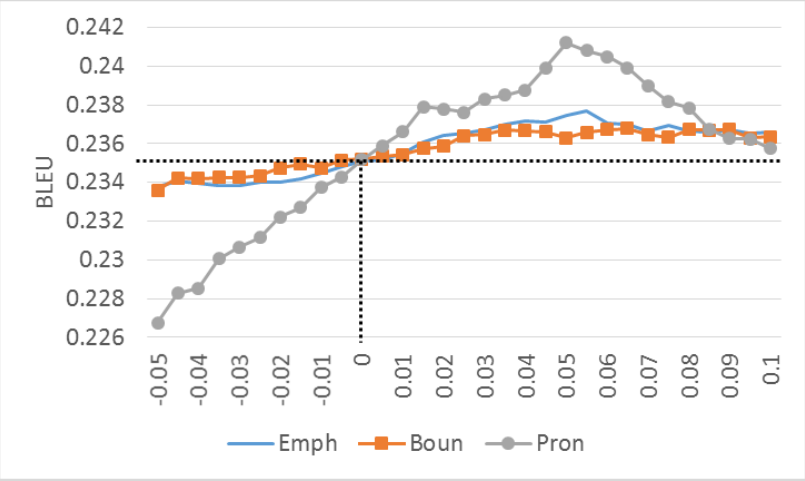
Language pair	Factor combination	Dev BLEU	Test BLEU
Chinese-English	Char→Word(Baseline)	19.23	13.60
	Char+Pron→Word	19.35	13.71
	Char+Boun→Word	19.33	**13.78***
	Char+Emph→Word	19.10	13.44
	Char+Pron+Boun→Word	19.30	13.70
English-Chinese	Word→Char(Baseline)	23.51	20.78
	Word→Char+Pron	23.60	20.92
	Word→Char+Boun	23.17	20.38
	Word→Char+Emph	23.56	20.91
	Word→Char+Boun+Emph	23.62	**20.99***

EXPERIMENTS

- Results of word lattice decoding with prosodic boundaries

Experiment	Test BLEU
Baseline	13.60
Word Lattice	**13.75**

- Results of re-ranking model with prosody



Rescore features	Dev BLEU	Test BLEU
Baseline	23.51	20.78
Pron	24.12	21.12*
Boun	23.67	20.79
Emph	23.77	21.02*
Pron+Boun+Emph	24.15	**21.29***

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CONCLUSION

- In this work, we exploited ways to enrich statistical machine translation with prosodic annotations:
  - Factored models with prosodic annotation
  - Word lattice decoding with prosodic boundaries
  - Re-ranking models with prosodic feature
- Character-level prosodic features can improve the performance of translation
- Further studies will focus on the effectiveness of high-level prosodic features for statistical machine translation.

REFERENCES

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THANKS!

Q&A