Reordering Rules for Phrase-based SMT

B. Chen, M. Cettolo, M. Federico

ITC-irst - Centro per la Ricerca Scientifica e Tecnologica

38050 Povo (Trento), Italy

Outline

- **Introduction**

- **Definition of Reordering Rule**

- **Application of Reordering Rules**

- **Experiments**

- **Conclusions**

Introduction

- **An important aspect of SMT is word reordering**

- **Reordering occurs when translation changes relative postion of words**

- **In SMT, word reordering is faced by**

  1. Constraints

  – **by limiting the number of possible reorderings**

  2. Modeling

  – **by asigning scores/probabilities to possible reordering**

- **We propose a linguistically motivated reordering model based on automatically extracted reordering rules**

Reordering Rules

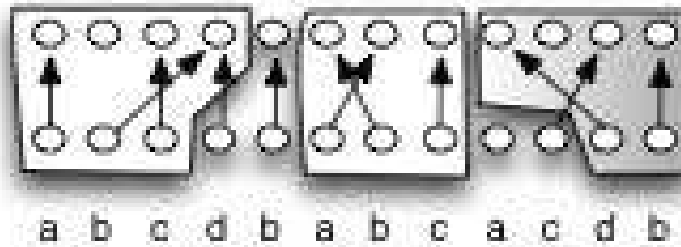- **At the level of:**

  - **Unit**

  - **Block (ngram) of units**

- **A unit can be:**

  - **POS (POS based rules)**

  - **Word (lexicalized rules)**

Block

Definition of Block:

- **a sequence of source units**

- **all occurrences of the sequence are aligned to consecutive positions**
  - **– experimentally, this check is relaxed a bit**
  - **– singletons are filtered out**

Note that a single unit is also a block.

In the example, the sequence "a b c" is a block, while "d b" is not.

Reordering Rule

- **Unit reordering rule:**

  – **lhs: block of units**

  – **rhs: normalized intra-alignment**

- **Block reordering rule:**

  – **lhs: two blocks**

  – **rhs: relative position of blocks**

- **Rules are weighted, according to statistics extracted from aligned training data.**

- **Rules are used in the rescoring of N-best lists as two additional feature functions.**

lhs	rhs	prob.
/rr /vmodal /v	2 1 3	0.45
	1 2 3	0.55

lhs	rhs	prob.
[/rr /vmodal /v] [/ng]	2 1	0.25
	1 2	0.75

Application of Reordering Rules

1. list all possible rules that match the input source sentence.

Test sentence:	我/rr	要/vmodal	送/v	餐/ng	服务/v	/wfullstop	
a) UnitREORDER	/rr	/vmodal	*	*	*	*	# 2 1 : p=0.52
b) UnitREORDER	/rr	/vmodal	*	*	*	*	# 1 2 : p=0.48
...							

Application of Reordering Rules (Cont.)

| I want | room service | . |

| 我/rr 要/vmodal | 送/v 餐/ng 服务/v | /wfullstop | # 1 1 2 2 2 3 |
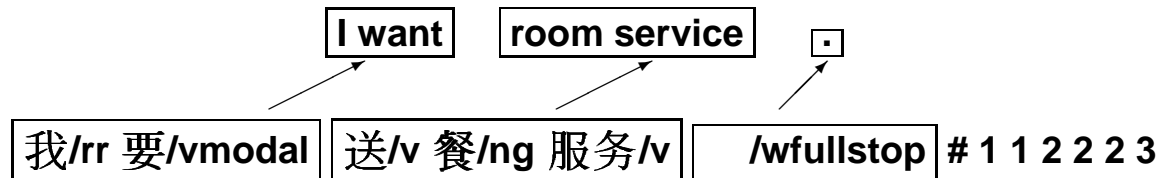
2. for each N-best entry, check if the rule is applied

  a. for each rule's lhs, extract its actual alignment

    – /rr /vmodal # 1 1

  b. match the alignment with the rule's reordering suggestion

    – alignment is over phrases, but rules involve the position of single units.

    – accept any rule which is "compatible" with the alignment.

    – Eg: for the rule pattern "/rr /vmodal", any reordering rule is compatible.

Application of Reordering Rules (Cont.)

3. compute the score

$$h_{\mathrm{rules}}(\tilde{\mathbf{e}}, \mathbf{f}, \mathbf{a}) = \frac{1}{K}(\sum_{i=1}^{K} \log P(r_{(i)1}^{n}|p_{(i)1}^{n})) \qquad \textbf{(1)}$$

K is the number of the reordering patterns matching the given source/target pair.

Translation Tasks and Data

- **Translation Tasks: BTEC data, Open data Track**

- **Language pairs:**

  - **Chinese-to-English (POS based rules and Lexicalized rules)**

  - **Japanese-to-English (Lexicalized rules)**

  - **Arabic-to-English (Lexicalized rules)**

- **Test sets: IWSLT04, IWSLT05, Devset4**

- **Dev set: CSTAR03**

- **BLEU%: no-case**

- **Non-monotone search: IBM S4 reordering constraints**

Chinese-to-English:	**MVD=6**	**MVN=6**
Japanese-to-English:	**MVD=8**	**MVN=8**
Arabic-to-English:	**MVD=4**	**MVN=4**

Statistics of Rules

● **Statistics of extracted and applied rules for Chinese-to-English**

		Chi-POS		Chi-LEX	
		Unit	Block	Unit	Block
Extracted		86K	1,743K	77K	3,002K
Matches	IWSLT'04	18,121	149,446	6,870	10,439
	IWSLT'05	19,259	162,873	8,046	12,451
	Devset4	19,245	272,364	6,987	7,375

Experimental Results

● **BLEU% scores on test sets**

		Chi-POS	Chinese	Japanese	Arabic
IWSLT	baseline	48.63	48.79	48.88	55.31
2004	unit+block	49.16	49.42	49.41	55.63
IWSLT	baseline	55.58	57.30	50.65	52.73
2005	unit+block	56.04	57.82	51.32	53.35
Devset4	baseline	16.45	17.05	16.24	21.24
	unit+block	17.36	17.44	16.61	21.64

– **Absolute improvement of the BLEU score: 0.4-0.9**

– **BLEU score are obtained without penalizing the NIST score.**

Translation examples

Translation examples for the Chinese-to-English task with POS rules

baseline	can i try on this **sweater cotton** ?
rescored	can i try on this **cotton sweater** ?
reference	may i try on this **cotton sweater** ?
baseline	are there any **clubs and pick up service rental** ?
rescored	do you have any **rental clubs and pick up service** ?
reference	do you have **rental clubs or a pick up service** ?
baseline	**i can get where** a city map ?
rescored	**where can i get** a city map ?
reference	**where can i get** a map of the city ?

Conclusions

- **Proposed a new word reordering method for SMT based on probabilitic rules:**

  - **automatically extracted from training data**

  - **suggesting movements of words or blocks**

  - **matching either word or POS pattern**

- **Rules are applied in the N-best rescoring stage**

- **Consistent improvements were obtained**

The End ... Thank You!