# Reordering Rules for Phrase-based SMT

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# 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

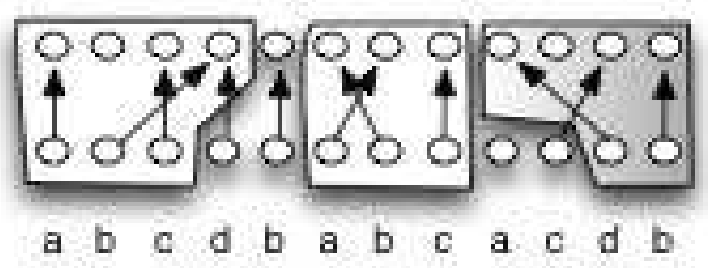
- At the level of:
  - Unit
  - Block (ngram) of units
- A unit can be:
  - POS (POS based rules)
  - Word (lexicalized rules)

# 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**

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

- **Block reordering rule:**
  - **lhs: two blocks**
  - **rhs: relative position of blocks**

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

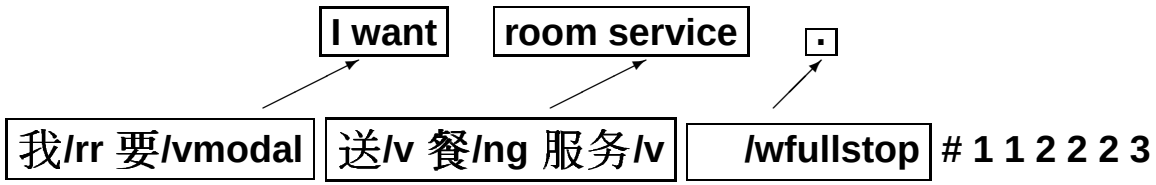
- **Rules are weighted, according to statistics extracted from aligned training data.**
- **Rules are used in the rescoring of N-best lists as two additional feature functions.**

# 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.)




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**

$$h_{\texttt{rules}}(\tilde{\mathbf{e}}, \mathbf{f}, \mathbf{a}) = \frac{1}{K}(\sum_{i=1}^{K} \log P(r_{(i)_1}^{n} | p_{(i)_1}^{n})) \quad \textbf{(1)}$$

**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 2004 | baseline | 48.63 | 48.79 | 48.88 | 55.31 |
| | unit+block | 49.16 | 49.42 | 49.41 | 55.63 |
| IWSLT 2005 | baseline | 55.58 | 57.30 | 50.65 | 52.73 |
| | 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!