Rule-Based Reordering on Multiple Syntactic Levels in SMT

Ge Wu | September 3, 2014

INSTITUTE FOR ANTHROPOMATICS AND ROBOTICS (IAR)

Outline

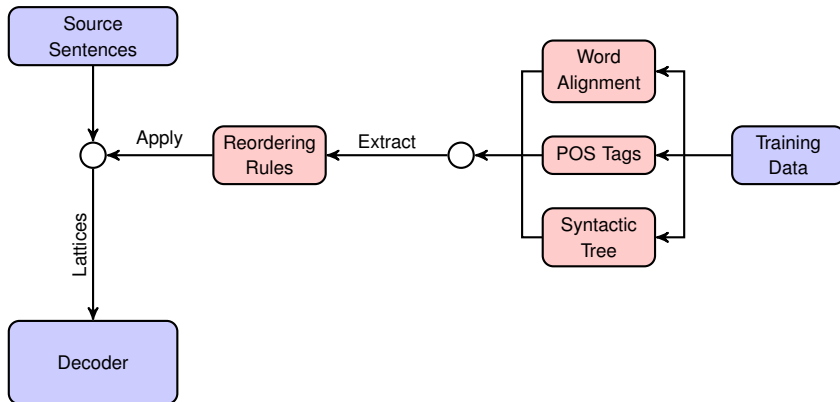# Introduction

- **Rule-based pre-ordering approaches** [Rottmann and Vogel 2007; Niehues and Kolss 2009; Herrmann et al. 2013]
- **Hierarchical phrase-based model** [Chiang 2007]
- More adaptive pre-ordering approach for Chinese based on syntactic structures

Pre-ordering System

Reordering Rules

- **Short rules** [Rottmann and Vogel 2007]

```
after the accident -> the accident after (0.5)

WRB MD DT -> DT WRB DT (0.3)
```

Reordering Rules

- Short rules [Rottmann and Vogel 2007]
- **Long rules [Niehues and Kolss 2009]**

```
NN * MD -> * MD NN (0.14)
```
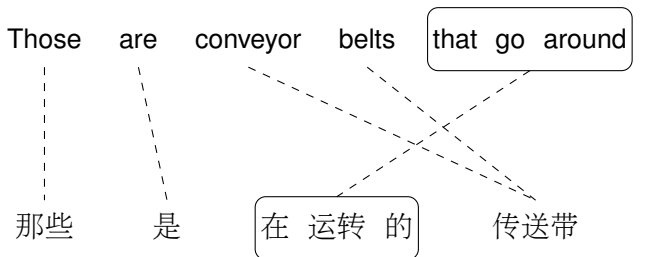
Reordering Rules

- **Short rules** [Rottmann and Vogel 2007]
- **Long rules** [Niehues and Kolss 2009]
- **Tree rules** [Herrmann et al. 2013]

```
NP ( ADJP JJ NN ) -> JJ NN ADJP (0.16)
```

Chinese Word Orders
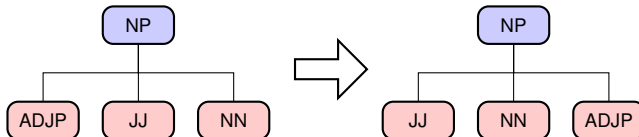
- **Pre-modifier instead of post-modifier**
    - Adverbials
    - Relative clauses
    - Preposition phrases

| Those | are | conveyor | belts | that go around | . |

那些　　是　　在 运转 的　　传送带　　。

Chinese Word Orders

- Pre-modifier instead of post-modifier
- **Questions**

How   will   you   cook   the   chicken   ?

You   will   how   cook   chicken   ?

你   会   怎么   做   鸡肉   呢   ?

Chinese Word Orders

- Pre-modifier instead of post-modifier
- Questions
- **Special sentence constructions**

There aren't many people around that are really involved with architecture as clients.

Never would India have thought on this scale before.
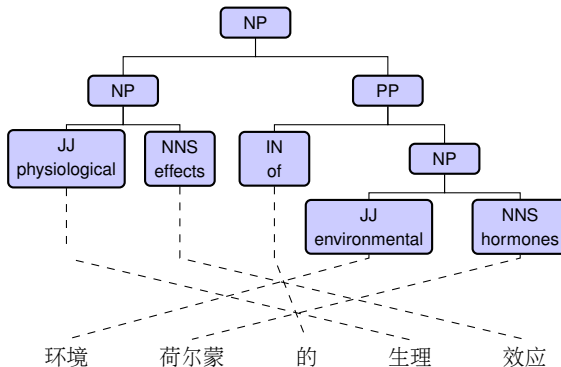
Chinese Word Orders

- Pre-modifier instead of post-modifier
- Questions
- Special sentence constructions
- **Long distance position change**

I find this very much disturbing when we are talking about what is going on right and wrong with democracy these days.
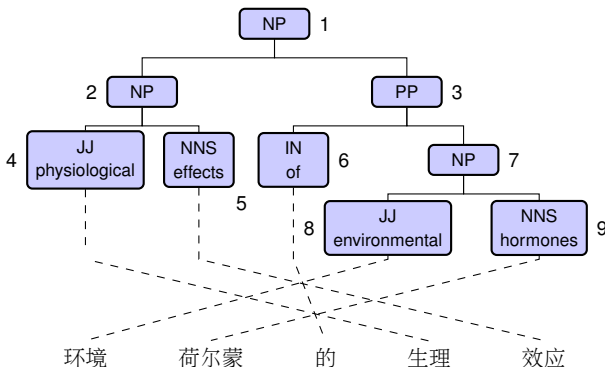
现在，每当我跟别人讨论我们的民主什么是对的，什么是错的我都为此觉得很无力。

Reordering on multiple syntactic levels

Extension of tree rule based reordering to multiple syntactic levels

Reordering Patterns

Introduction

Multi-Level-Tree (MLT) Reordering
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Evaluation
○○

Conclusion

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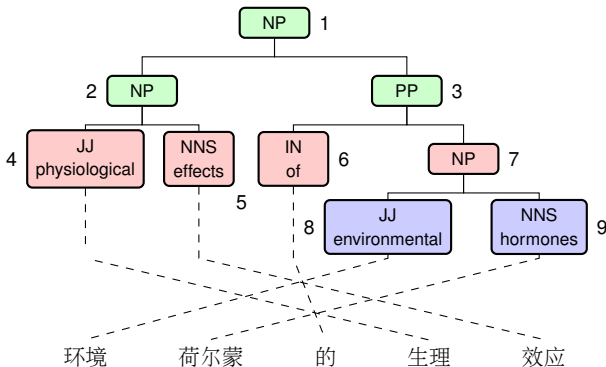
Reordering Patterns
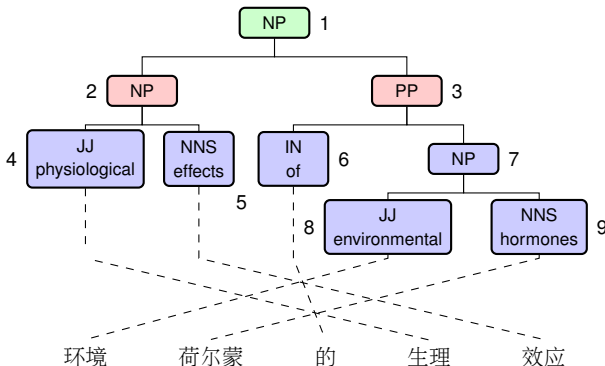

```
Root Depth Pattern
1    1     NP ( NP₀ PP₁ ) -> 1 0
```

Reordering Patterns
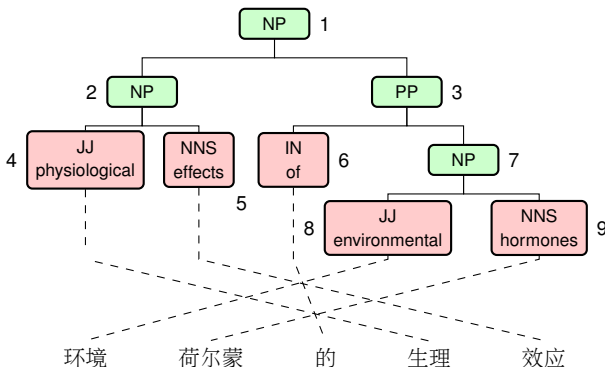


```
Root  Depth  Pattern
1     1      NP ( NP₀ PP₁ ) -> 1 0
1     2      NP ( NP ( JJ₀ NNS₁ ) PP ( IN₂ NP₃ ) ) -> 3 2 0 1
```

Reordering Patterns


```
Root  Depth  Pattern
1     1      NP ( NP₀ PP₁ ) -> 1 0
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1     3      NP ( NP ( JJ₀ NNS₁ ) PP ( IN₂ NP ( JJ₃ NNS₄ ) ) ) -> 3 4 2 0 1
```

Reordering Patterns


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3     1     PP ( IN₀ NP₁ ) -> 1 0
```

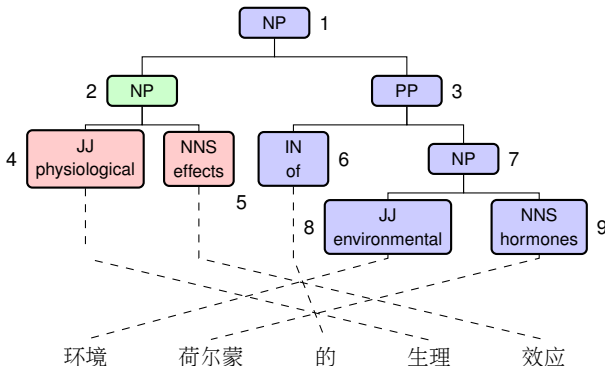# Reordering Patterns


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3     1      PP ( IN₀ NP₁ ) -> 1 0
3     2      PP ( IN₀ NP ( JJ₁ NNS₂ ) ) -> 1 2 0
```

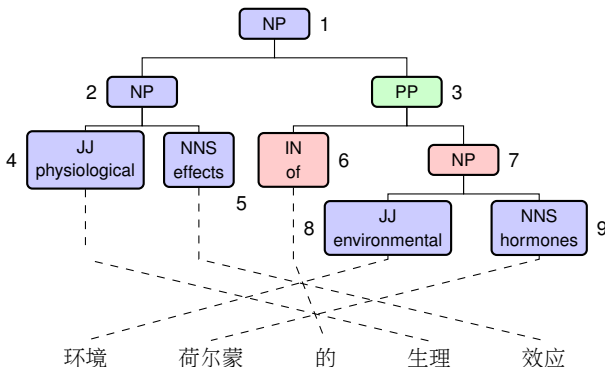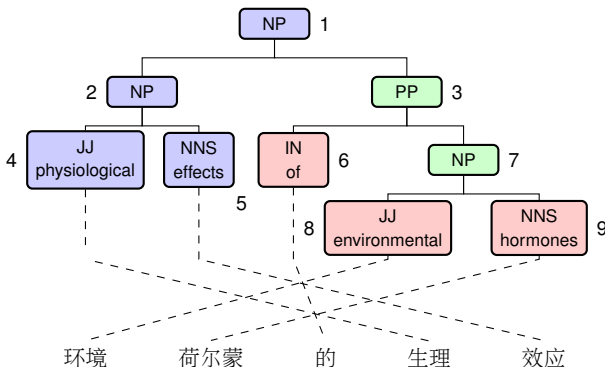# Reordering Patterns


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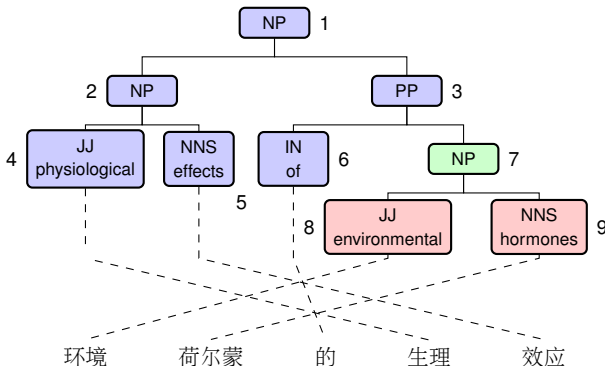
Rule Extraction

- **Search from all nodes with all possible depths**
- Rule probability

```
ADJP ( JJ , JJ ) -> 0 1 2     (0.84239130 = 310 / 368)
ADJP ( JJ , JJ ) -> 0 2 1     (0.02989130 =  11 / 368)
ADJP ( JJ , JJ ) -> 1 0 2     (0.07880435 =  29 / 368)
ADJP ( JJ , JJ ) -> 1 2 0     (0.02173913 =   8 / 368)
ADJP ( JJ , JJ ) -> 2 0 1     (0.02717391 =  10 / 368)
```

- Rule pruning
- Rule number doubles in comparison with tree rules

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- Rule pruning
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Rule Application

- **Search from all nodes with all possible depths**
- Search depth decreases to avoid duplicate applications

```
PP ( IN₀ NP₁ ) -> 1 0
PP ( IN₀ NP ( JJ₁ NNS₂ ) ) -> 1 2 0
```

- Reorderings as paths in word lattices (size doubles approx.)
- Threshold for adding a path

Rule Application

- Search from all nodes with all possible depths
- **Search depth decreases to avoid duplicate applications**

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- Reorderings as paths in word lattices (size doubles approx.)
- **Threshold for adding a path**

Results: English -> Chinese

Data: LDC & TED, 1 reference   Train: 75MB / 454K sentences
Dev: 164KB / 919 sentences   Test: 263KB / 1663 sentences

	BLEU Score	Improvement	TER
Baseline	12.07		72.15
+Short Rules	12.50	0.43	71.41
+Long Rules	12.99	0.92	70.71
+Tree Rules	13.38	1.31	68.27
+MLT Rules	13.81	1.74	68.20
Oracle Reordering	**18.58**	**6.51**	**62.13**
Long Rules	12.31	0.24	71.81
Tree Rules	13.30	1.23	70.42
MLT Rules	13.68	1.61	70.25

Results: Chinese −> English

Data: LDC, 3 references   Train: 47MB / 303K sentences
Dev: 142KB / 919 sentences   Test: 220KB / 1663 sentences

	BLEU Score	Improvement	TER
Baseline	21.80		62.09
+Short Rules	22.90	1.10	61.64
+Long Rules	23.13	1.33	61.43
+Tree Rules	23.84	2.04	60.95
+MLT Rules	24.14	2.34	60.79
Oracle Reordering	**26.80**	**5.00**	**56.97**
Long Rules	22.10	0.30	62.21
Tree Rules	23.35	1.55	61.52
MLT Rules	23.96	2.16	60.83

Conclusion

- **Better translation quality**
  - English to Chinese: **1.61** Improvement of BLEU score
  - Chinese to English: **2.16** Improvement of BLEU score
- Better syntactic structure
  - More possible reorderings
  - Improvement for more complicated reorderings
- Space for further improvement

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Outlook

- **Better reordering approaches**

- Vector presentation instead of POS tags as features

- Reordering with less information

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- Better reordering approaches
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Thank you for your attention

Introduction

Multi-Level-Tree (MLT) Reordering
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○○

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Data Size

English -> Chinese

Data Set		#Sentence	#Word		Size (Byte)	
			English	Chinese	English	Chinese
Training Data	LDC	303K	10.96M	8.56M	60.88M	47.27M
	TED	151K	2.58M	2.86M	14.24M	15.63K
Development Data		919	30K	25K	164K	142K
Test Data		1663	47K	38K	263K	220K

Chinese -> English

Data Set	#Sentence	#Word		Size (Byte)	
		Chinese	English	Chinese	English
Training Data	303K	8.56M	10.96M	47.27M	60.88M
Development Data	919	25K	30K	142K	164K
Test Data	1663	38K	47K	220K	263K

Lattice Size

SKIT
Karlsruhe Institute of Technology

System: English -> Chinese
Data set: test data

	Number of Rules	Size of Lattices
Short Rules	362873	13M
Long Rules	106081	6.8M
Tree Rules	5067	7.3M
MLT Rules	10312	12M

Reordering on multiple syntactic levels

References I
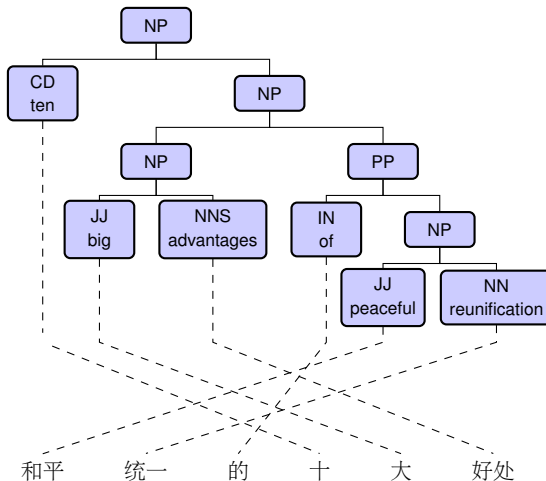
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