Constituency to Dependency Translation with Forests

Haitao Mi and Qun Liu

presented by Yang Liu

Institute of Computing Technology
Chinese Academy of Sciences
Constituency Trees in SMT

string-to-constituency

constituency-to-string

constituency-to-constituency

(Galley et al., 2006; Liu et al., 2006; Zhang et al., 2007)
Dependency Trees in SMT

string-to-dependency

dependency-to-string

dependency-to-dependency

(Shen et al., 2008; Xiong et al., 2007; Quirk et al., 2005)
Constituency-to-Dependency

Bush held a talk with Sharon
Synchronous Generation

IP

VP

NPB

X_1:NPB

X_2:VP

X_1

X_2
Synchronous Generation
Synchronous Generation
Synchronous Generation

IP

NPB
bushi

Bush

VP

X1:PP

X2:VPB

X1

X2
Synchronous Generation
Synchronous Generation
Synchronous Generation
Synchronous Generation

Tree diagram showing the syntactic structure of a sentence with labeled nodes for NPB, P, PP, VP, and VPB. The sentence contains the words "bushi" and "Bush" with "yu" and "with" marked for processing in a syntactic analysis framework.
Synchronous Generation

ACL 2010, Uppsala, Sweden
Synchronous Generation

ACL 2010, Uppsala, Sweden
Synchronous Generation

ACL 2010, Uppsala, Sweden
Synchronous Generation

bushi yu shalong

Bush with Sharon

a held

ACL 2010, Uppsala, Sweden
Synchronous Generation

[Diagram of syntactic tree with labels]

ACL 2010, Uppsala, Sweden
Synchronous Generation

bushi yu shalong juxing le

Bush held with Sharon

huitan talk

NPB P NPB VS AS NPB
Synchronous Generation

bushi yu shalong juxing le huitan

Bush held

huitan talk

huitan talk

Sharon talk with

bushi yu shalong juxing le

NPB P NPB VS AS NPB

NPB VP VPB PP
Packed Forest

(Billot and Lang, 1989; Klein and Manning, 2001; Huang and Chiang, 2005)
Rule Extraction

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"

"Bush □ with (Sharon)"  "held … (Sharon)"
Rule Extraction

“Bush □ with (Sharon)”

“held … (Sharon))”

“with (Sharon)”

“held ((a) talk)”

“Bush □ with (Sharon)”

“held … (Sharon))”

“with (Sharon)”

“held ((a) talk)”

“Bush □ with (Sharon)”

“held … (Sharon))”

“with (Sharon)”

“held ((a) talk)”

“Bush □ with (Sharon)”

“held … (Sharon))”

“with (Sharon)”

“held ((a) talk)”
Rule Extraction

“Bush with (Sharon)”

“held … (Sharon))”

“with (Sharon)”

“held ((a) talk)”

“Bush”

“with”

“with”

“Sharon”

“held”

“”

“talk”

Bush

a

talk

with

held

Sharon

Bush

a

talk

with

held

Sharon
Rule Extraction

“(Bush) … (Sharon)”

“Bush □ with (Sharon)”

“with (Sharon)”

“held … (Sharon)”

“(a) talk)”

“IP”

“X1:NPB”

“X2:VP”

“Bush”

“with”

“Sharon”

“talk”

“bushi”

“yu”

“shalong”

“juxing”

“le”

“huitan”

“a”

“talk”

“Sharon”

“held”
Rule Extraction

“Bush □ with (Sharon)”
“with (Sharon)”
“held … (Sharon))”

“Bush… (Sharon))”

“Bush with (Sharon)”
“Sharon”
“held (a talk)”

“Bush □ with (Sharon)”
“with” “with”
“Sharon”
“held” “”
“talk”

bushi yu shalong juxing le huitan

Bush talk with

held

7/22/10 ACL 2010, Uppsala, Sweden 25
Decoding

NPB
  | bushi
  ↓
Bush

NPB
  0,1
  | bushi
  ↓
NPB
  0,3
  | CC
  ↓
CC
  1,2
  | P
  ↓
P
  1,2
  | NP
  ↓
NP
  0,3
  | VS
  ↓
VS
  3,4
  | AS
  ↓
AS
  4,5
  | NPB
  ↓
NPB
  5,6
  | VP
  ↓
VP
  1,6
  | P
  ↓
P
  1,2
  | NPB
  ↓
NPB
  0,1

PP
  1,3
  | VS
  ↓
VS
  3,4
  | AS
  ↓
AS
  4,5
  | NPB
  ↓
NPB
  2,3
  | VP
  ↓
VP
  3,6
  | NPB
  ↓
NPB
  2,3

IP
  0,6
  | VP
  ↓
VP
  1,6
  | NPB
  ↓
NPB
  0,1
Decoding

NPB bushi
CC yu
NPB shalong

NP0,3
IP0,6

PP1,3
VP1,6

NP0,1 CC1,2 P1,2 NPB2,3

bushi yu shalong

VS3,4 AS4,5 NPB5,6

juxing le huitan NP0,1 CC1,2 NPB2,3
Decoding
Decoding

bushi

yu

shalong

huitan

Bush

with

Sharon

talk

VPB

VS

AS

X1:NPB

juxing

le

a

X1

held

NPB

PP

VP

IP

P

NP

NPB

CC

1,2

1,3

0,1

0,3

0,6

1,6

2,3

3,4

4,5

5,6

bushi

yu

shalong

huitan

NPB

CC

NPB

NPB

VS

AS

NPB

NPB

P

NP

PP

VP

IP

P

NP

NPB

CC

NPB

NPB

NPB

NPB

NPB

NPB
Decoding

“Bush” “held” “((a) talk)” “(with (Sharon))”

“Bush” “with” “Sharon”

“held” “((a) talk)”
Evaluation

- Task: Chinese-English
- Training set: FBIS (6.9M+8.9M words)
- LM: 4-gram trained on Gigaword Xinhua
- Development set: NIST 2002
- Test set: NIST 2005
- Metric: case-insensitive BLEU4
## Results

| System               | Rule                         | Type | Well-formed? | Number | BLEU  |
|----------------------|------------------------------|------|--------------|--------|-------|
| **Constituency-to-String** |                             |      |              |        |       |
| C2S                  | No                           |      |              | 31.9M  | 34.17 |
| S2S                  | No                           |      |              | 77.9M  |       |
| C2S                  | Yes                          |      |              | 13.8M  | 32.48 |
| S2S                  | Yes                          |      |              | 9.0M   |       |
| C2S                  | Yes                          |      |              | 13.8M  | 34.03 |
| S2S                  | No                           |      |              | 77.9M  |       |
| **Constituency-to-Dependency** |                       |      |              |        |       |
| C2D                  | Yes                          |      |              | 13.8M  | 33.25 |
| S2D                  | Yes                          |      |              | 9.0M   |       |
| C2D                  | Yes                          |      |              | 13.8M  | 34.88 |
| S2D                  | No                           |      |              | 77.9M  |       |
Conclusion and Future Work

- Constituency-to-dependency combines the advantages of constituency-to-string and string-to-dependency:
  - Decoding is fast
  - Better target side generation

- Future work
  - Larger data and more language pairs
  - Comparison with constituency-to-constituency
  - Dependency forest
Thank you!
Improving Rule Coverage

bushi yu shalong juxing le huitan

juxing le huitan

held a talk

NPB

AS

VS

VPB

PP

NP

IP

VP

NPB

PP

NP

IP

VP

NPB