Experiments in English ↔ Japanese Tree-to-String Machine Translation

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10/20/2012

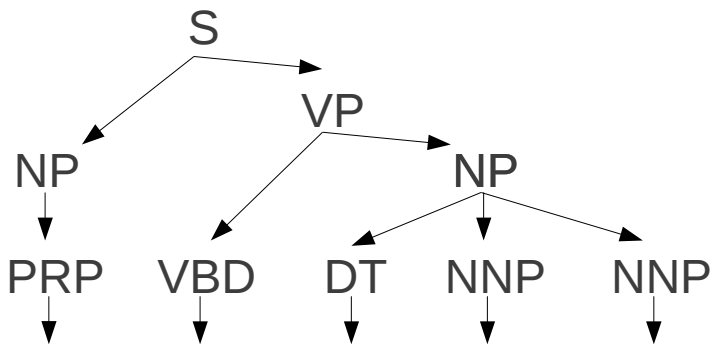
Introduction/Motivation

Translation Models

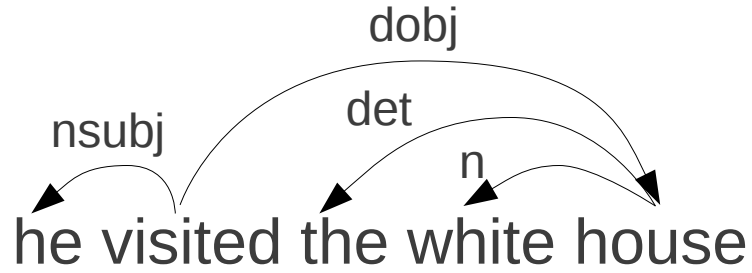
string

he visited the white house

tree (phrase structure)



dependency

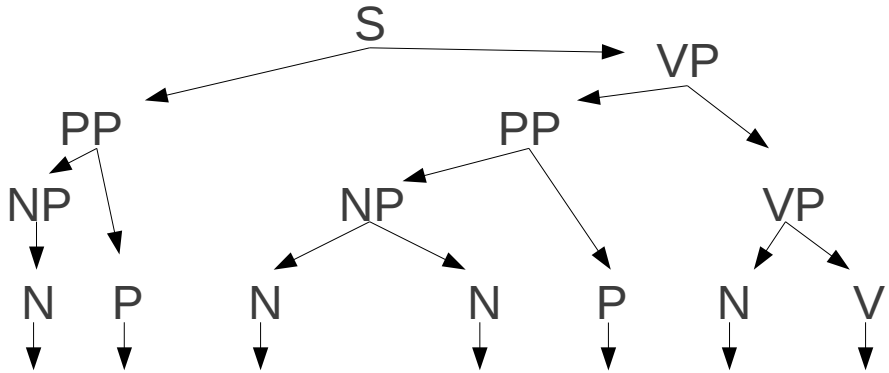


to

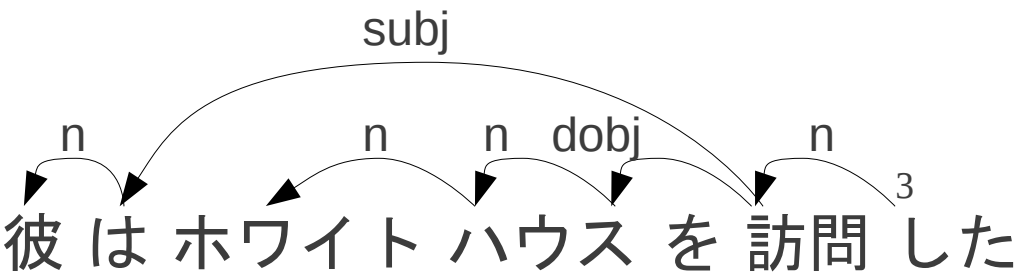
string

彼 は ホワイト ハウス を 訪問 し

tree (phrase structure)

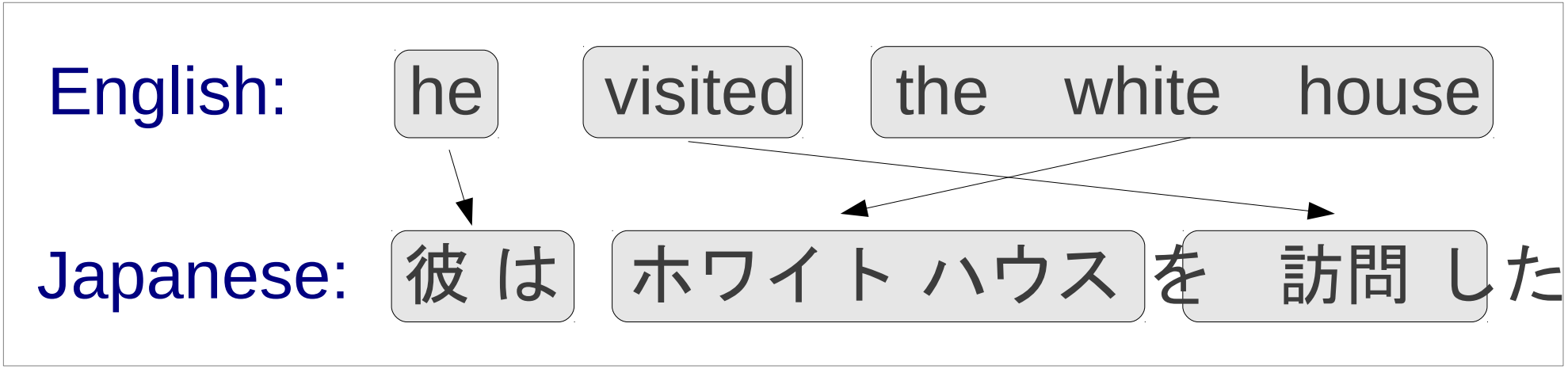


dependency



Recent Usage in English ↔ Japanese

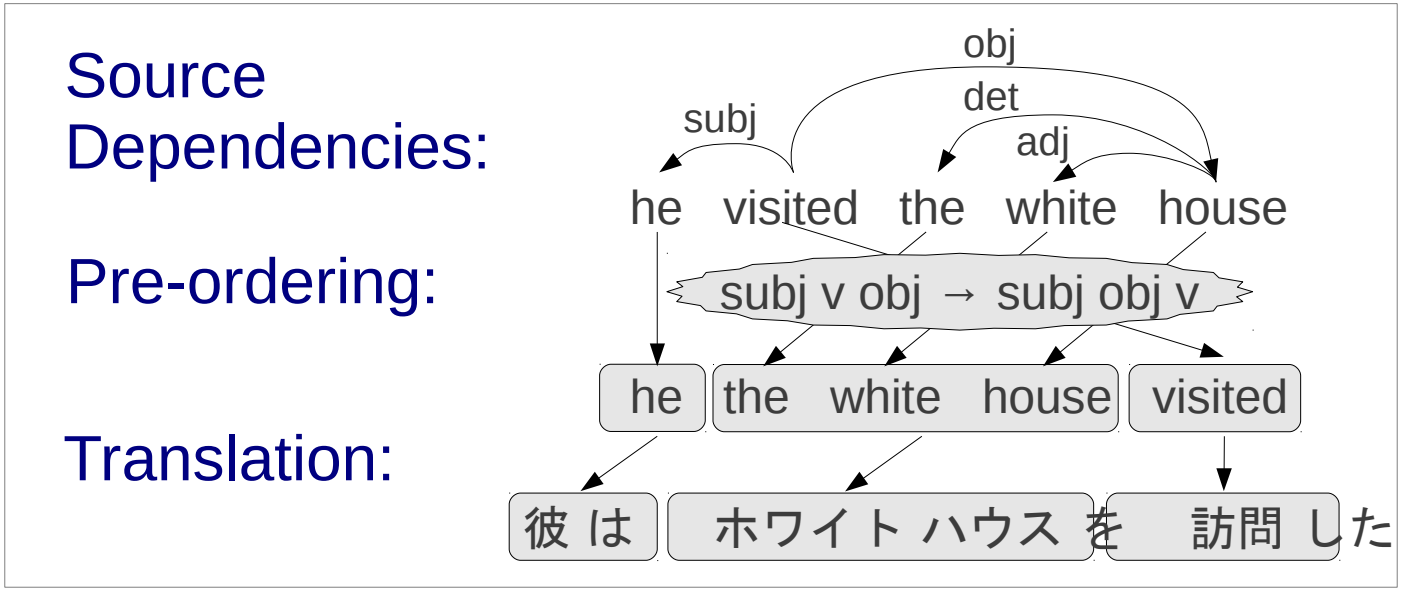
- Phrase-based translation [Koehn+ 03] is still popular



- Moses used in 25 papers at NLP2012
- Also, hierarchical phrase-based translation [Chiang 07] ([Feng+ 11] is one of the few examples)

Recent Usage in English ↔ Japanese

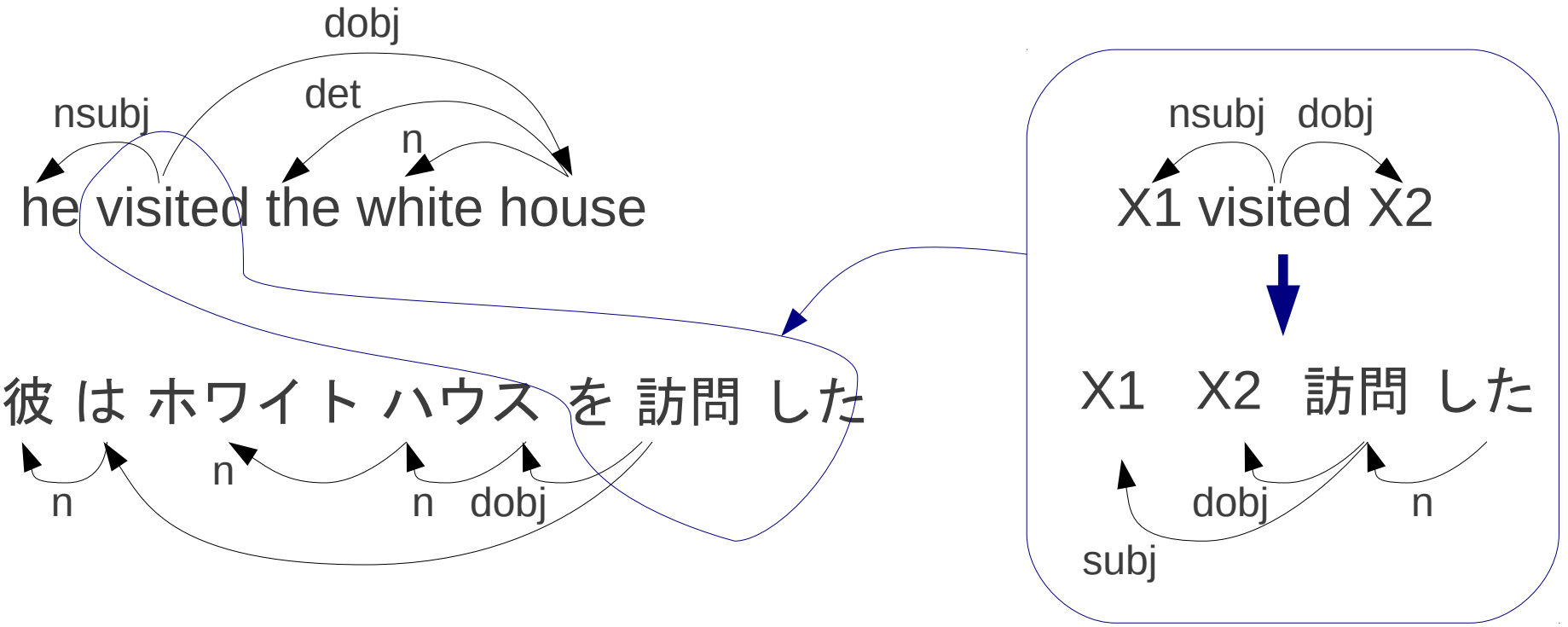
- Pre-ordering [Xia+ 04] is another popular technique



- First used for Japanese by [Komachi+ 06]?
- Used by Google [Xu+ 09], NTT [Isozaki+ 11], others [Nguyen+ 08, Neubig+ 12]

Recent Usage in English ↔ Japanese

- Dependency-to-dependency used by Kyoto U [Nakazawa+ 06] and rule based systems



Recent Usage in English ↔ Japanese

- String-to-tree models [Yamada+ 01] used by NTT in NTCIR task [Sudoh+ 11]

Recent Usage in English ↔ Japanese

string

he visited the white house

(H)PBMT

string

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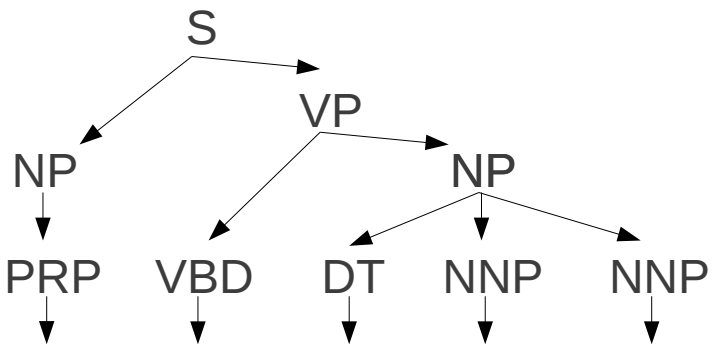
tree (phrase structure)

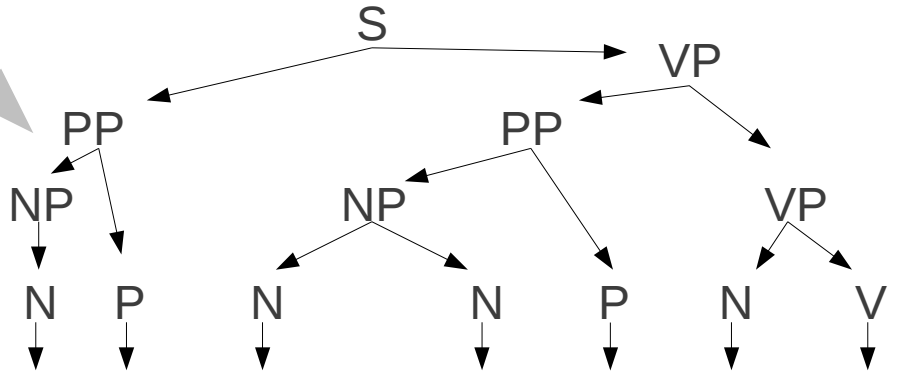
S2T



he visited the white house

Pre-ordering

tree (phrase structure)



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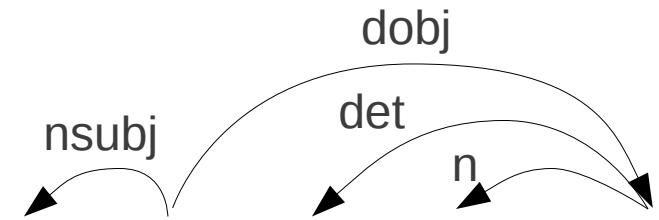
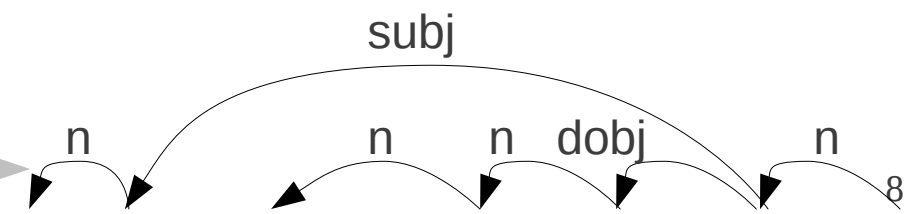
dependency



he visited the white house

D2D

dependency



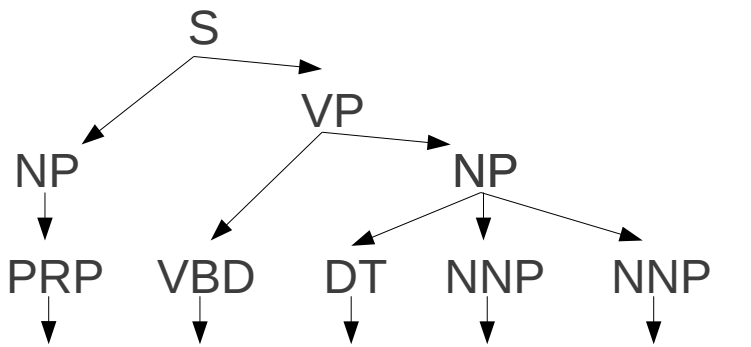
彼 は ホワイト ハウス を 訪問 した

What about Tree-driven Models?!

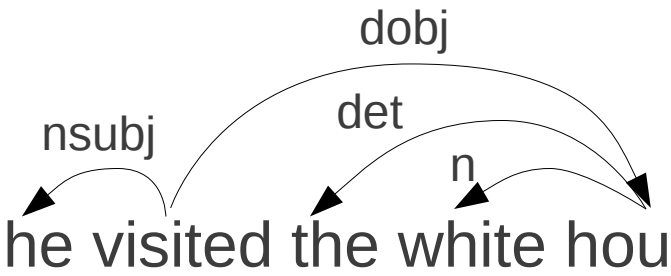
string

he visited the white house

tree (phrase structure)



dependency



T2S

D2S

string

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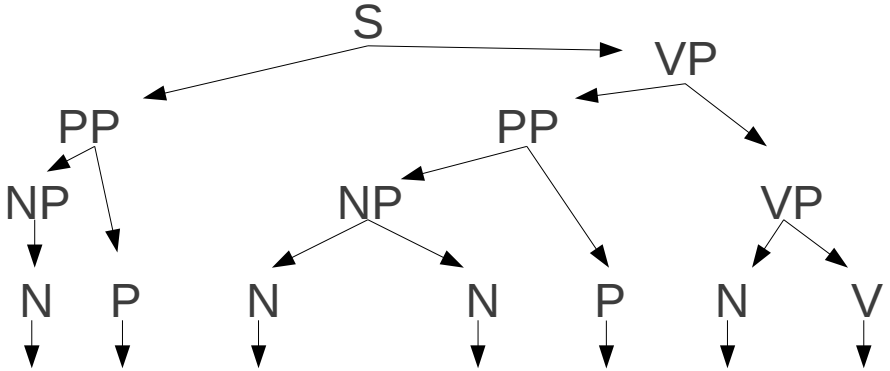
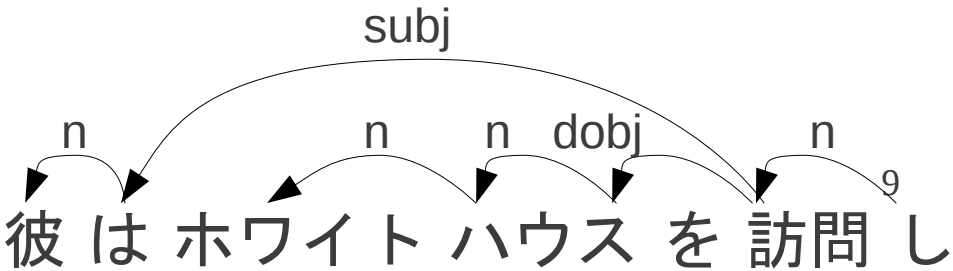
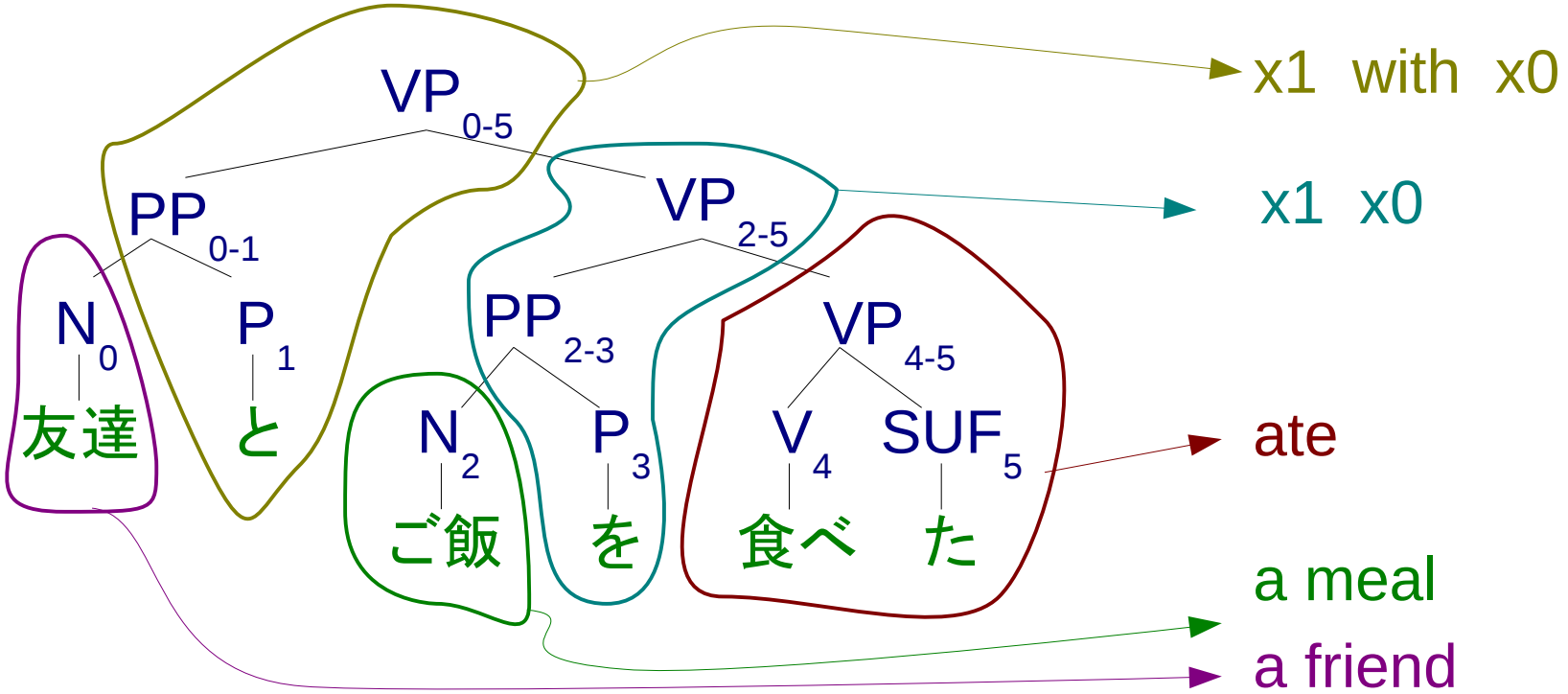
tree (phrase structure)



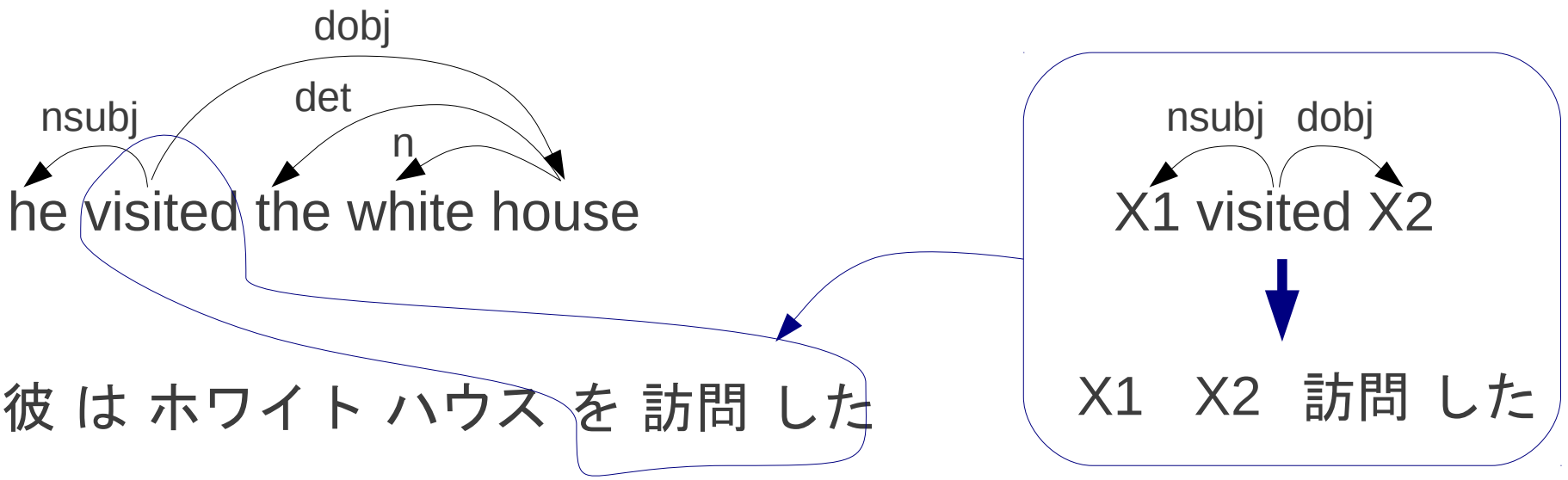
dependency



Tree-to-String Models [Liu+ 06]



Dependency-to-String Models [Quirk+ 05]

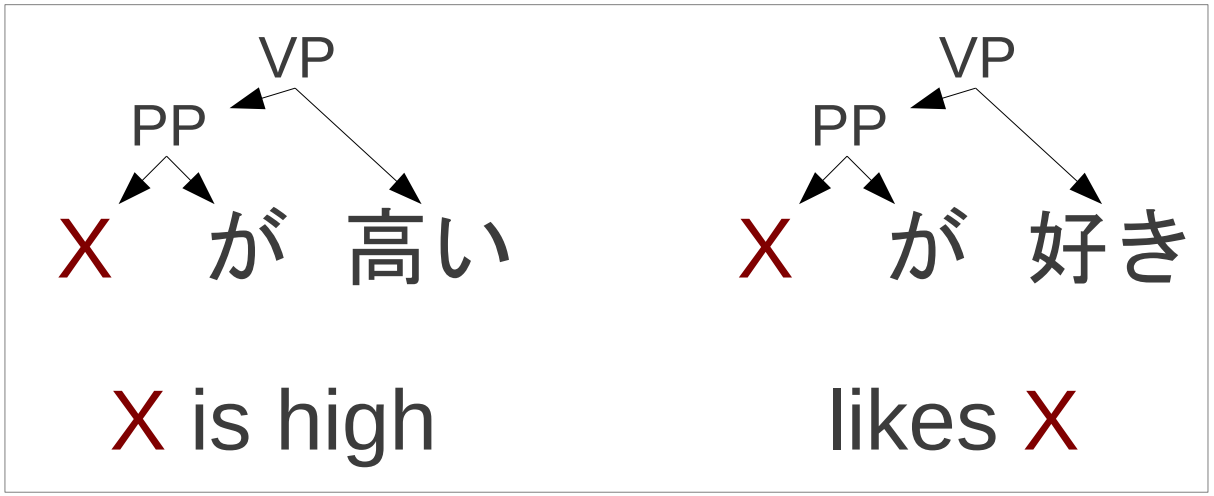


T2S/D2S vs Phrase Based

- + Better reordering through use of syntactic structure
- + Very fast! (especially compared to HPBMT)
- + Better lexical choice because long-range context considered (especially D2S)
- - Requires a parser
- - Sensitive to parse errors

T2S/D2S vs Pre-ordering

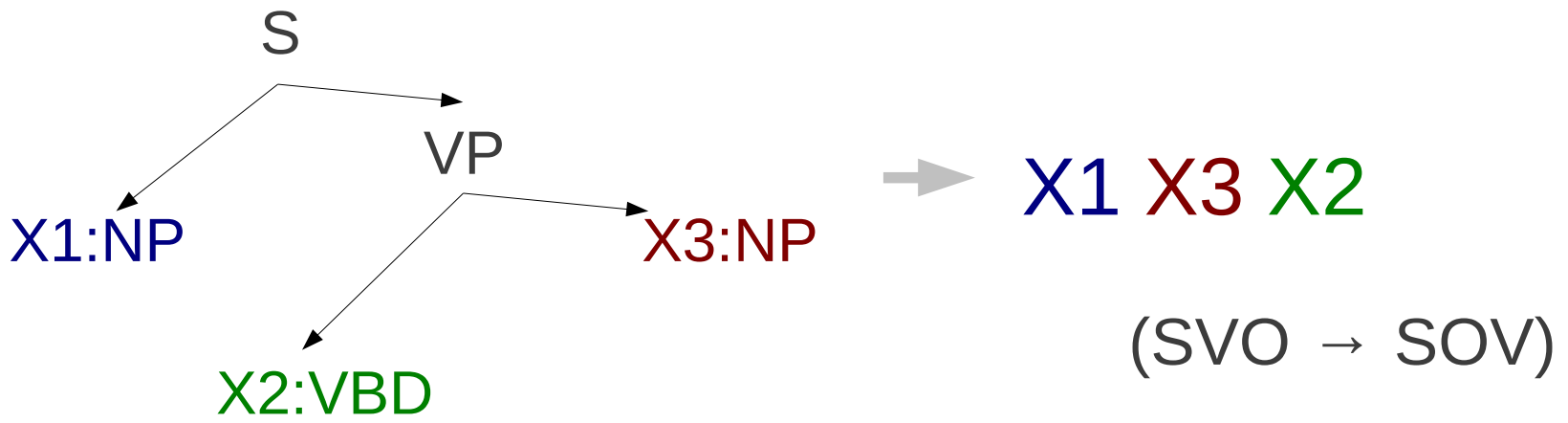
- + T2S/D2S jointly searches for reordering and translation
- + T2S/D2S can easily handle lexicalized reordering



- - Pre-ordering can find translation rules that overlap constituent boundaries

T2S vs. D2S

- T2S: Can handle de-lexicalized rules = more general?



- D2S: Dependent words are close → good for lexical choice?

Experiments and Summary

Question:

How well do modern statistical tree-to-string methods work for English ↔ Japanese translation?

Previous Research

- Three examples for En→Ja?
  - [Quirk+ 06] Uses dependency treelet translation and shows improvement over PBMT
  - [Wu+ 10] Uses HPSG input and shows improvement over Joshua (HPBMT)
  - [DeNero+ 11] Shows forest-to-string does slightly better than syntactic pre-ordering in terms of BLEU
- One example for Ja→En?
  - [Menezes+ 05] Uses dependency treelet translation, no direct comparison to other methods

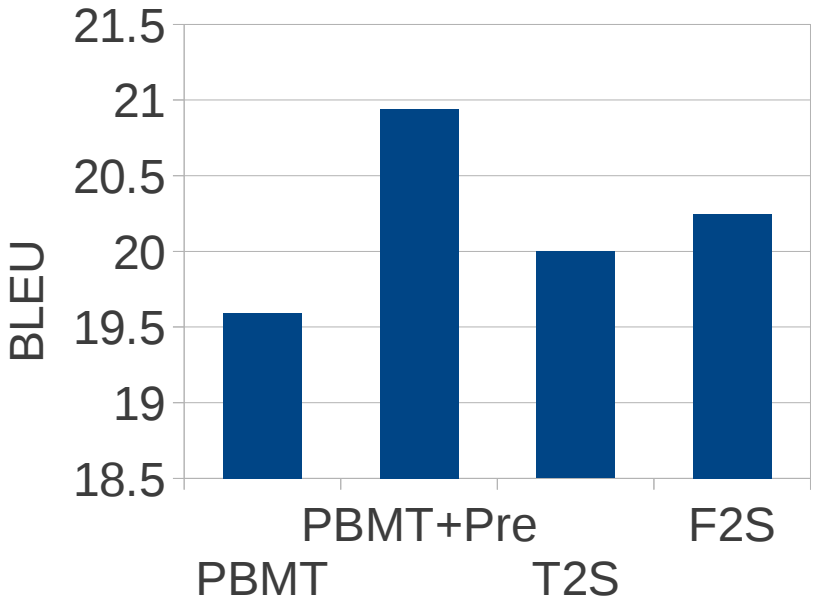
Experimental Setup

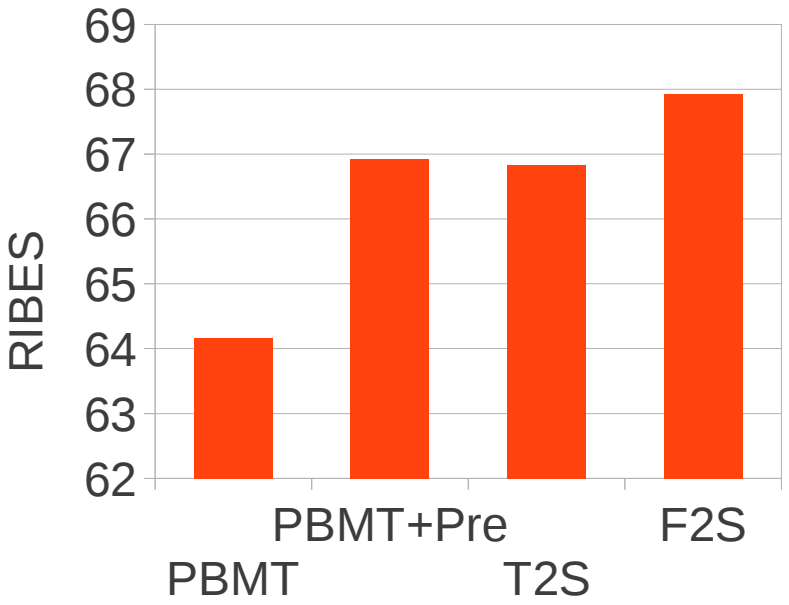
- System: In-house forest-to-string decoder “travatar”
  - Forest-to-string translation [Mi+ 08] with tree transducers
  - Alignment GIZA++, extraction GHKM, tuning MERT
- Data: Kyoto Free Translation Task (KFTT [Neubig 11]), ~350k sentences of Wikipedia data for training
- Baseline: Moses PBMT, PBMT + Preordering [Neubig+ 12]
- Evaluation: BLEU, RIBES, Acceptability (0-5)

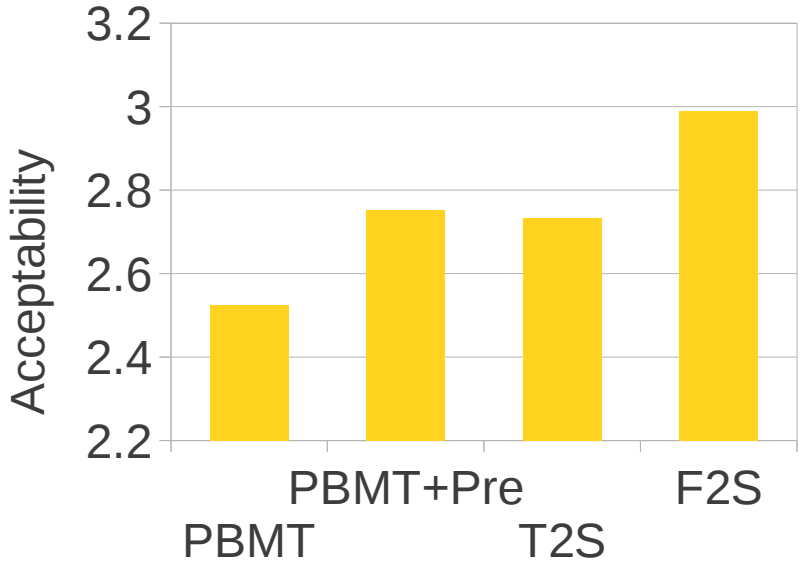
Tree-to-String Settings (Explained in Detail Later)

- Language Analysis:
  - En Parser: Stanford, Berkeley, **Egret** (Tree, Forest)
  - Ja: Juman+KNP, MeCab+Cabocha, **KyTea+EDA**
- Composed Rules: 1, 2, 3, **4**
- Non-terminals: 1, **2**, 3
- Binarization: Left, **Right**
- Null Attachment: Top, Exhaustive (**1**, 2)
- Tuning: BLEU, RIBES, **(BLEU+RIBES)/2**

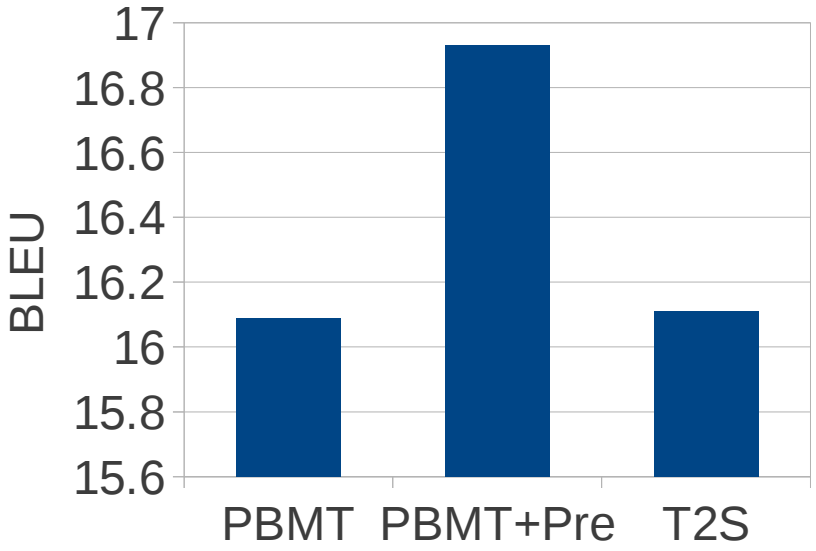
Summary (En-Ja)

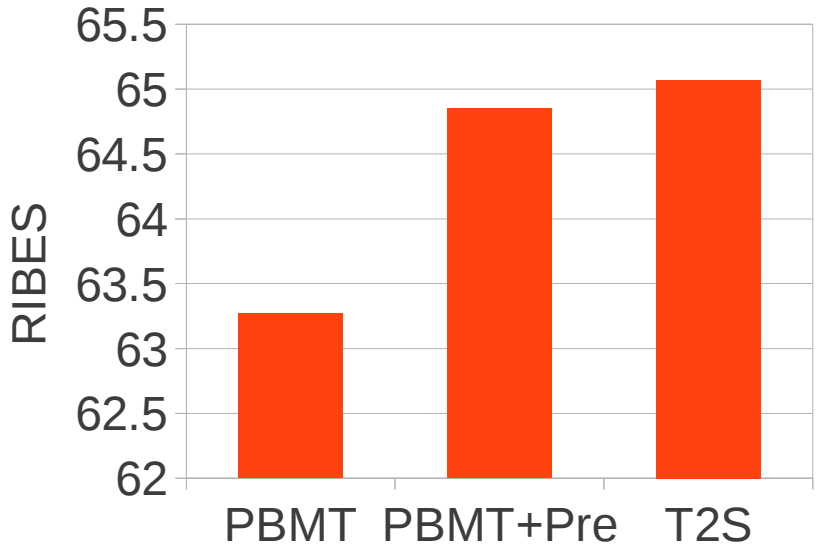


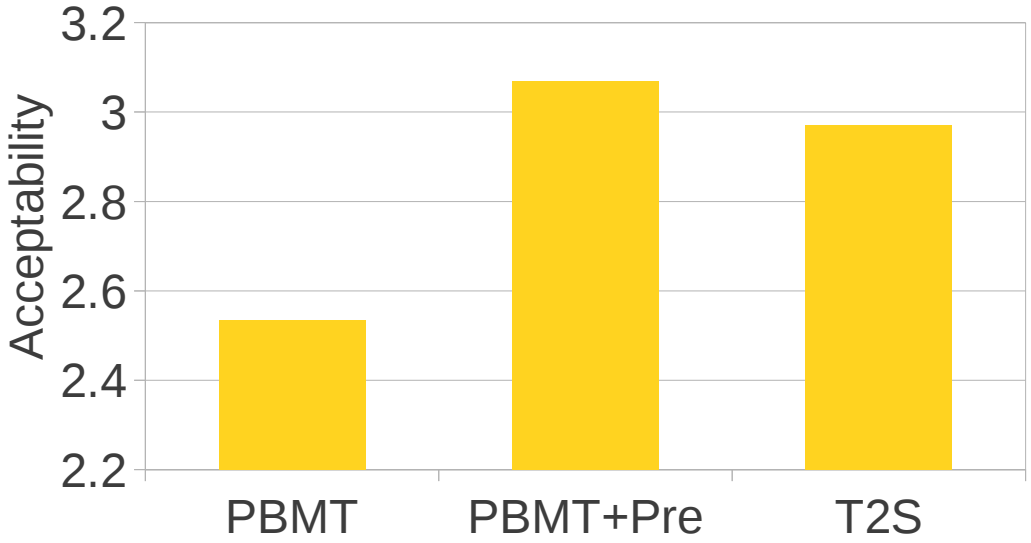




Summary (Ja-En)







En-Ja F2S vs. PBMT+Pre

Input:
Department of Sociology in Faculty of Letters opened .

PBMT+Pre:
開業 年 文学 部 社会 学科 。

F2S:
文学 部 社会 学 科 を 開設 。

Properly interprets noun phrase + verb

En-Ja F2S vs. PBMT+Pre

Input:
Afterwards it was reconstructed but its influence declined .

PBMT+Pre:
その 後 衰退 し た が 、 その 影響 を 受け て 再建 さ れ た もの で あ る 。

F2S:
その 後 再建 さ れ て い た が 、 影響 力 は 衰え た 。

Properly reconstructs relationship between two verb phrases

En-Ja F2S vs. PBMT+Pre

Input:
Introduction of KANSAI THRU PASS Miyako Card

PBMT+Pre:
スルッと kansai 都 カード の 導入

F2S:
伝来 スルッと KANSAI 都 カード

Parsing error:
(NP (NP Introduction) (PP of KANSAI THRU PASS) (NP Miyako) (NP Card))

Ja-En T2S vs. PBMT+Pre

Input:
史実 に は 直接 の 関係 は な い 。

PBMT+Pre:
in the historical fact is not directly related to it .

T2S:
is not directly related to the historical facts .

Properly translates “ に は … 関係 が” as “related to”

Ja-En T2S vs. PBMT+Pre

Input:

九条 道家 は 嫡男 ・ 九条 教実 に 先立 た れ 、 次男 ・ 二条 良実 は 事実 上 の 勘当 状態 に あ っ た 。

PBMT+Pre:

michiie kujo was his eldest son and heir , norizane kujo , and his second son , yoshizane nijo was disinherited .

T2S:

michiie kujo to his legitimate son kujo norizane died before him , and the second son , nijo yoshizane was virtually disowned .

Much better division between clauses

Ja-En T2S vs. PBMT+Pre

Input:
日本 語 日本 文学 科
1474 年 ~ 1478 年 - 山名 政 豊

PBMT+Pre:
the department of japanese language and literature
in 1474 to 1478 - masatoyo yamana

T2S:
japanese language and literature
masatoyo yamana 1474 shokoku-ji in -

Errors due to more restrictive rule extraction (first example), parse errors (second example, “Yamana” is a single noun phrase)

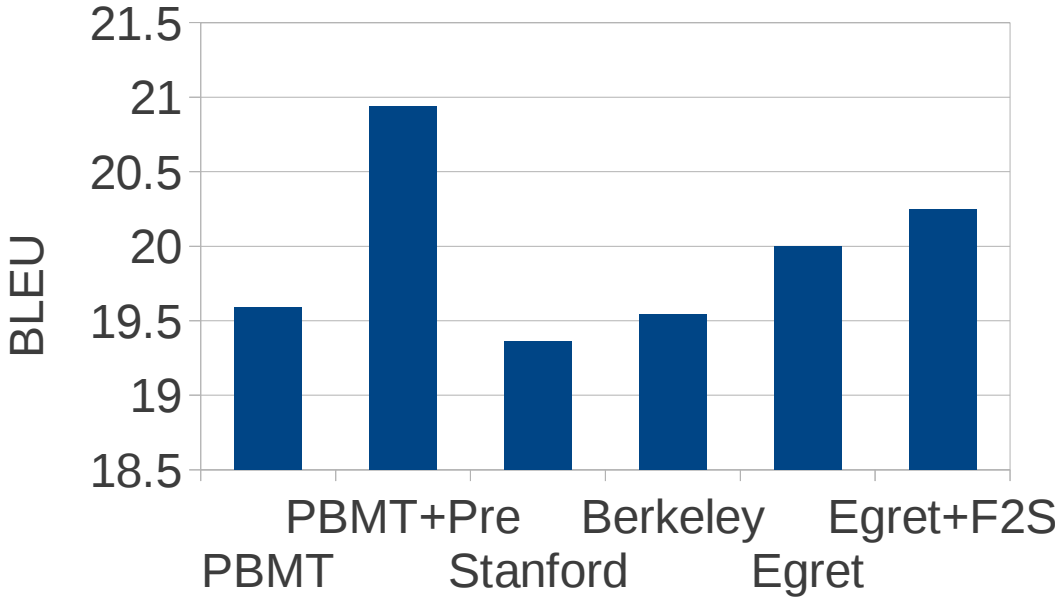
Effect of Language Analysis

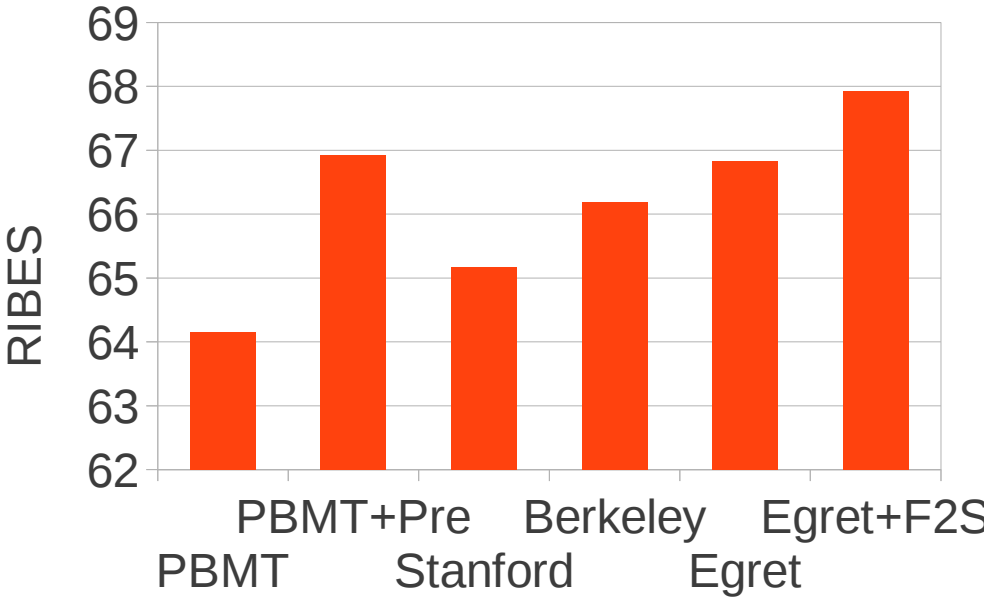
Question:

How much do the language analysis tools used effect translation?

Language Analysis (En-Ja):

- Which parser provides better translations?
- Stanford Parser, Berkeley Parser, Egret (a clone of the Berekely parser that can output forests)





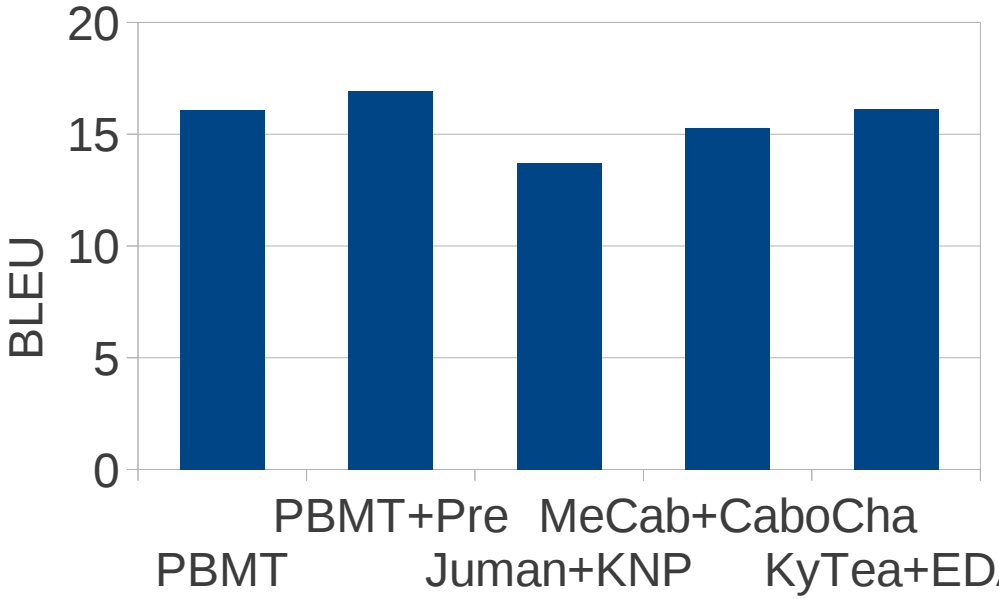
Language Analysis (Ja-En):

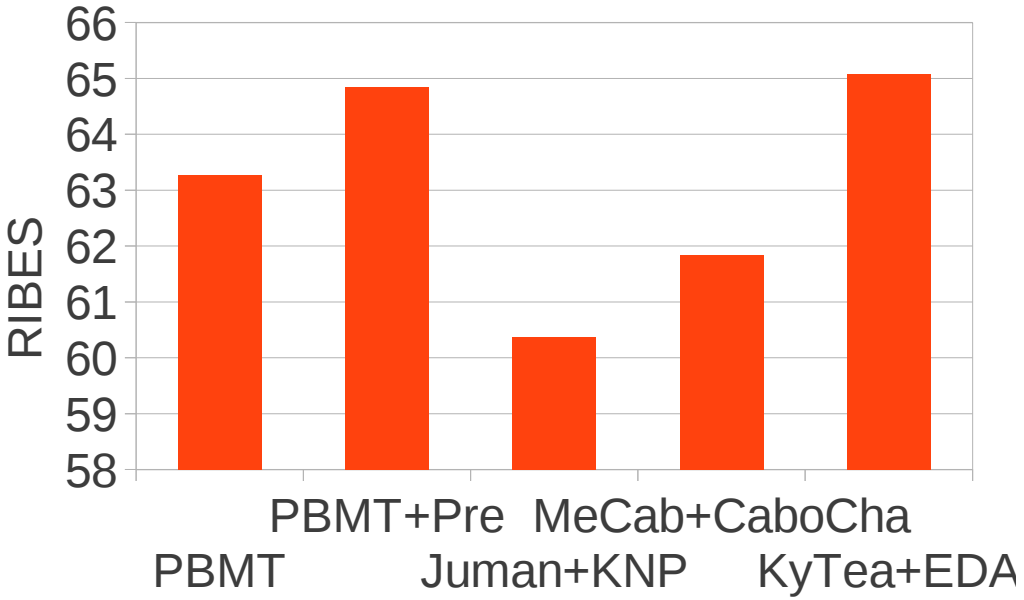
- 3 morphological/dependency analysis combinations

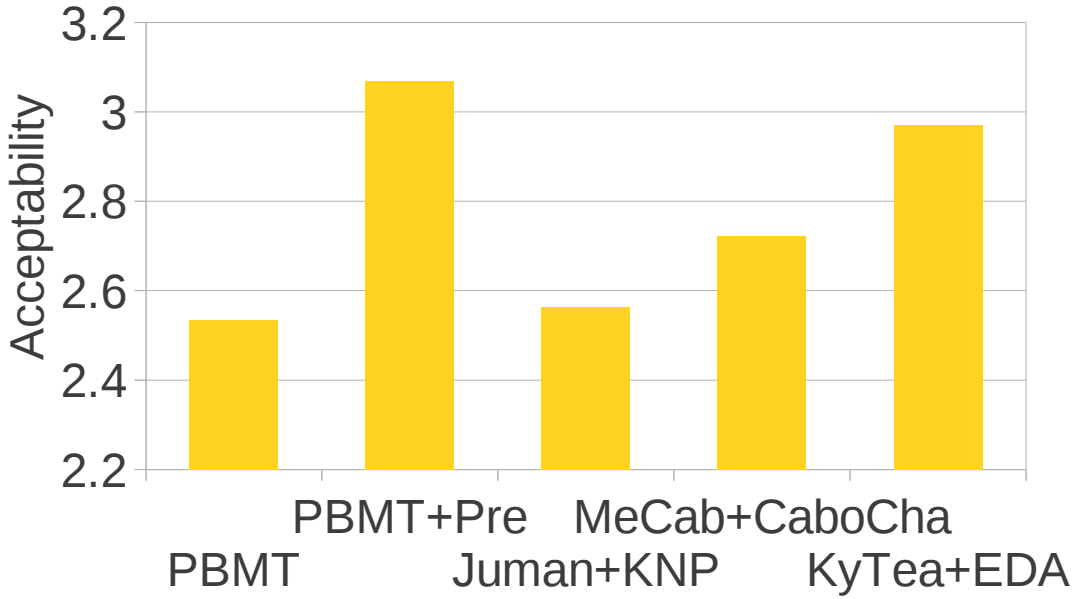
	Juman+KNP	MeCab+CaboCha	KyTea+EDA
Segmentation	Long	Medium	Short
OOV	Simple	Simple	Model
Parsing Unit	Bunsetsu	Bunsetsu	Word
Algorithm	CKY-Style	Cascaded Chunking	MST

- Use head rules to change dependency into CFG
  - For bunsetsu-based, last content word is head
  - Punctuation dependencies reversed

Language Analysis (Ja-En):







EDA vs. KNP/CaboCha

Input:
向嶽寺派
祇園女御妹-後に平忠盛妻

MeCab+CaboCha:
向嶽寺 school
祇園女御 younger sister : later became the wife of taira no tadamori

KyTea+EDA:
kogaku-ji temple school
gion no nyogo younger sister - , later taira no tadamori 's wife

Smaller, more accurate segmentation provides better translations (EDA)

EDA vs. CaboCha/KNP

Input:
大宮学舎旧守衛所
文学部社会学科を設置

MeCab+CaboCha:
former omiya campus . office
department of faculty of letters society was established .

KyTea+EDA:
omiya campus former guard office
department of sociology , faculty of letters was established .

Word-based noun-phrase parsing helps translation (EDA)

EDA vs. CaboCha/KNP

Input:
芳崖と雅邦はともに地方の狩野派系絵師の家の出身であった。

MeCab+CaboCha:
hogai and gaho both was from a family of local painters of the kano school .

KyTea+EDA:
hogai and gaho from the family of the region of the kano together school series painter .

CaboCha/KNP wins followed no clear pattern. This case:
CaboCha: “とみに→出身” EDA: “ともに→地方”

CaboCha vs. KNP

Input:
谷万太郎
1391年-山名氏清
1392年 ~ 1394年-畠山基国

Most prominent wins for CaboCha were segmentation

JUMAN/KNP:
taro million tani
in 1391 , - the yamana clan
- in 1392 - 1394 hatakeyama) province

MeCab+CaboCha:
mantaro tani
1391 , : ujikiyo yamana
1392 1394 : motokuni hatakeyama

Conclusion

- Egret is best for English, and forests are important.
- KyTea+EDA is best for Japanese
  - At the moment, morphological analysis is more important than parsing?
- Future directions:
  - Forest-based parser!
  - Better bunsetsu→word dependency conversion rules

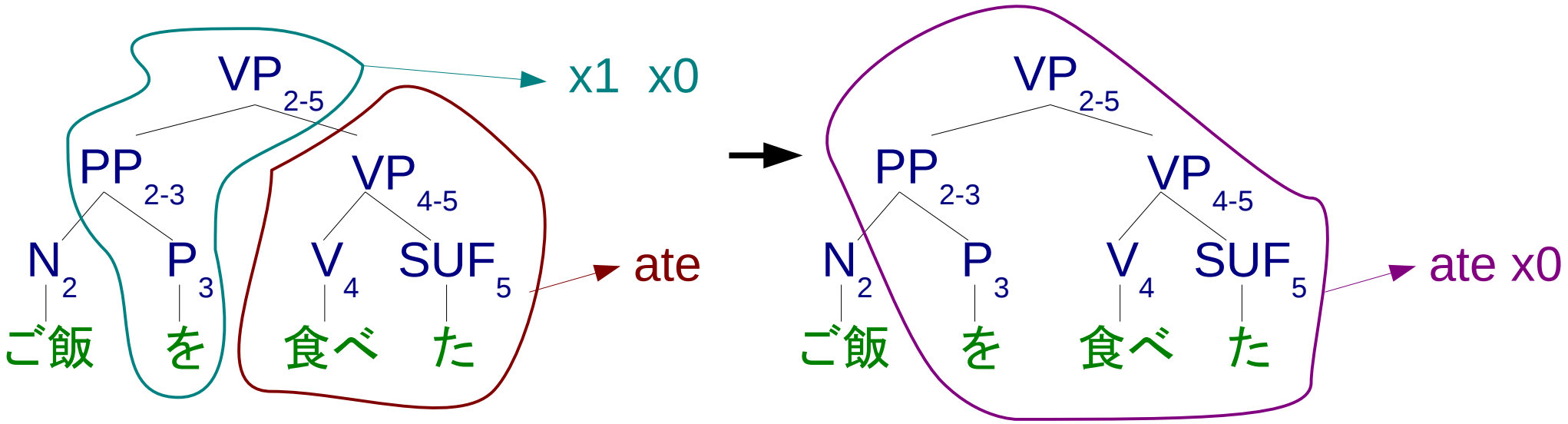
Other Settings

Question:

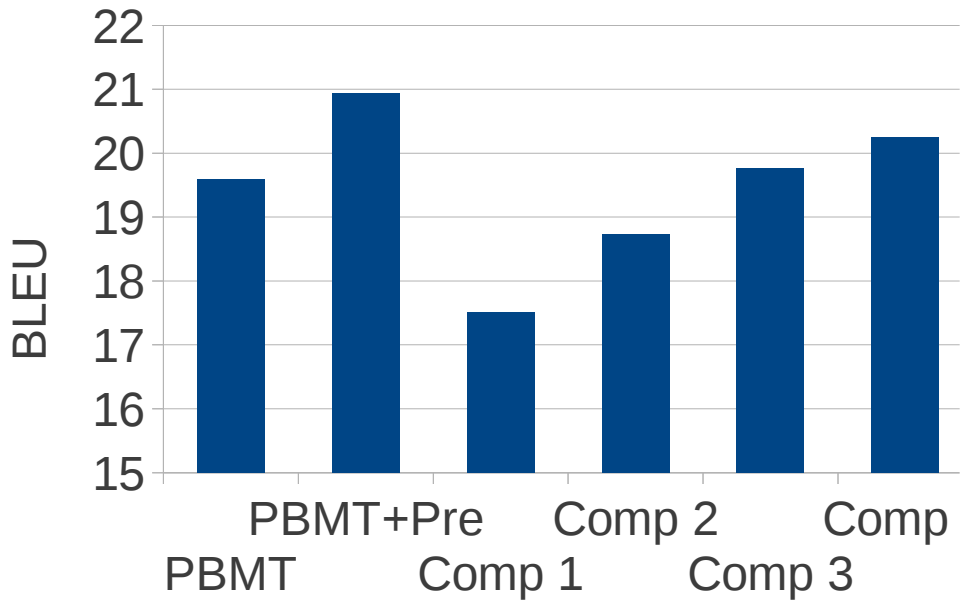
What other settings have a significant effect on translation results?

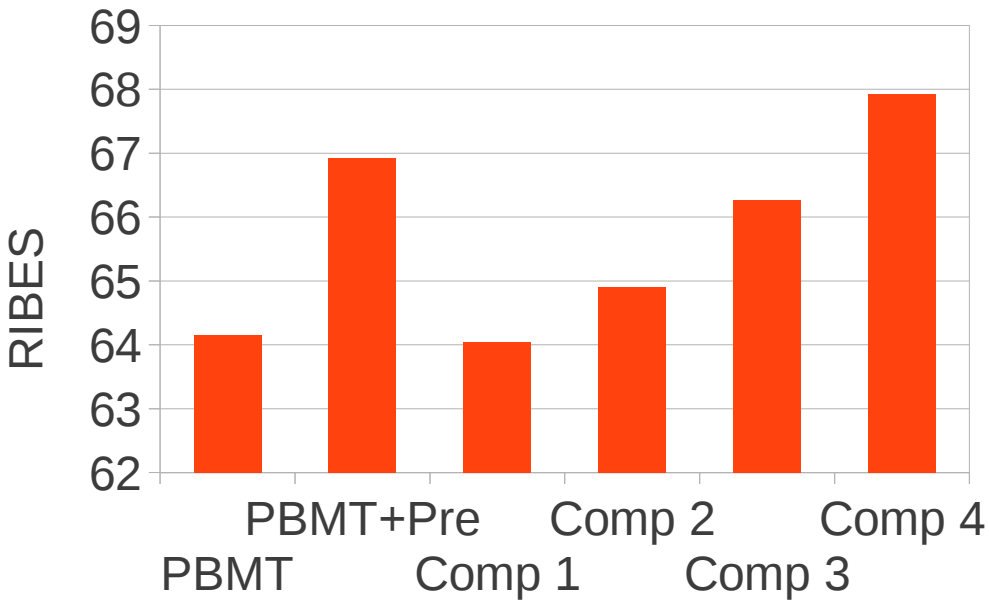
Composed Rules

- Combine two minimal rules into larger rules:



Composed Rules (En-Ja)

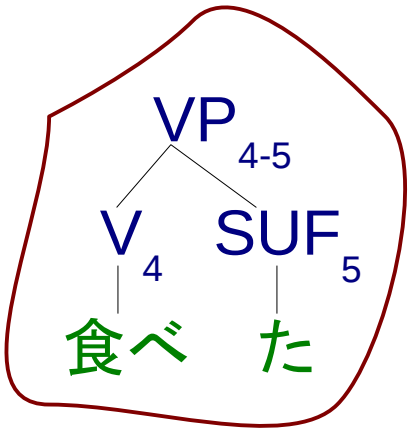




- Composed rules are very important

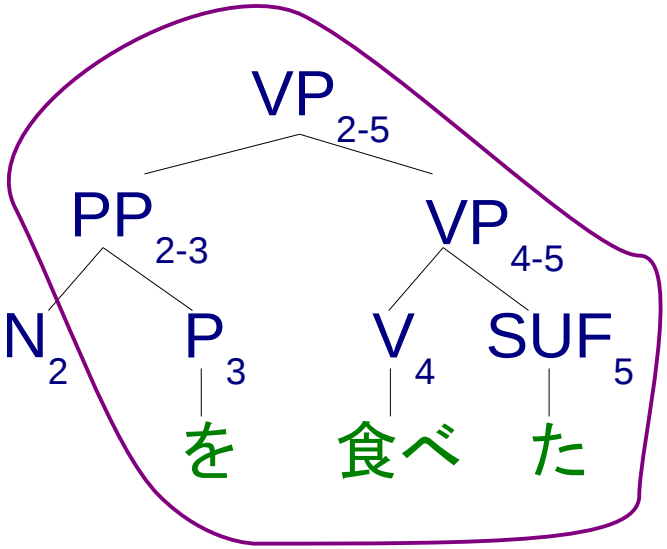
Number of Non-Terminals

0 NT



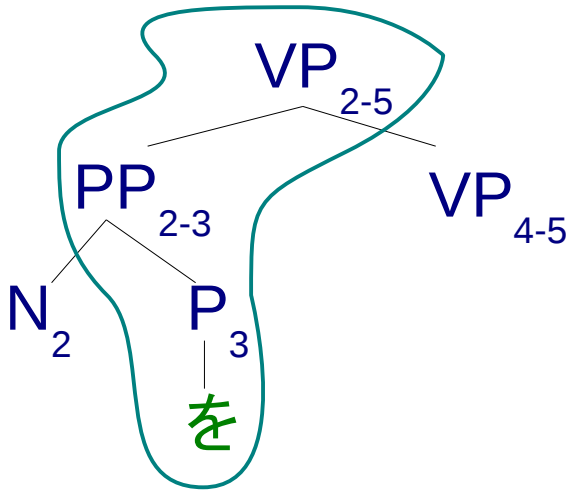
ate

1 NT



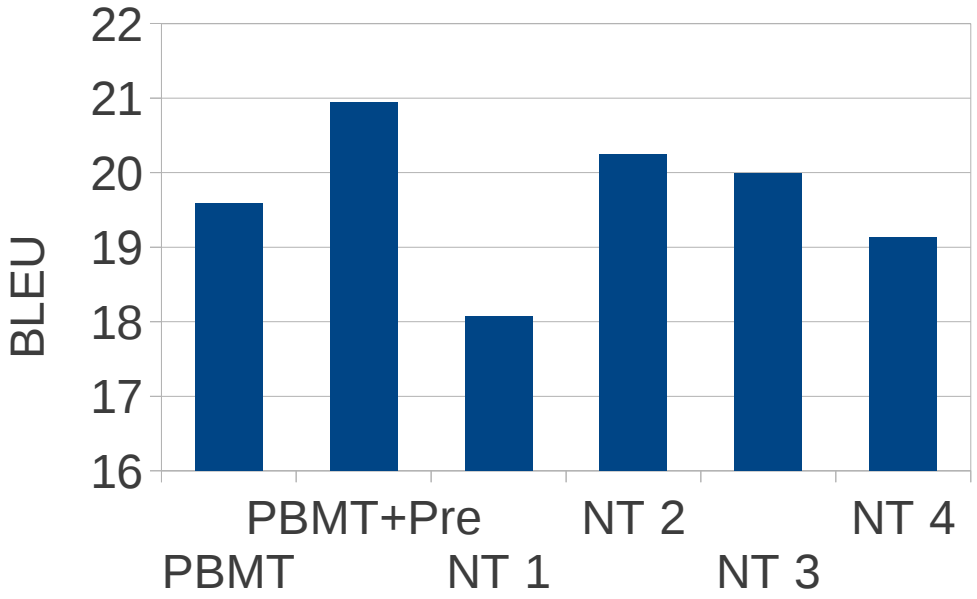
ate x0

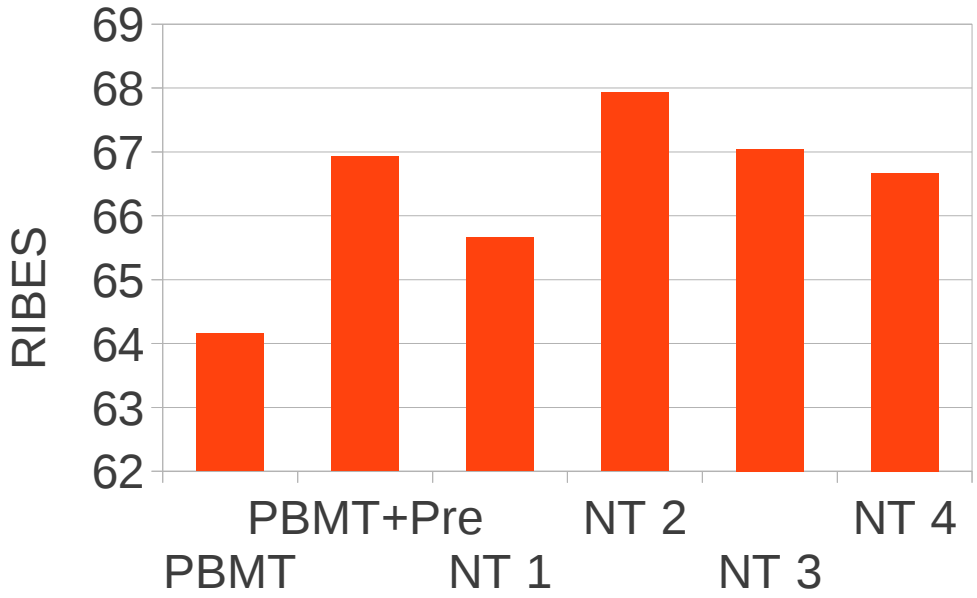
2 NT



x1 x0

Number of Non-Terminals (En-Ja)

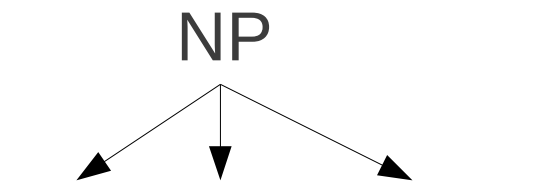




- 2 Non-terminals are necessary, but more are harmful
- Why? Larger are more noisy?

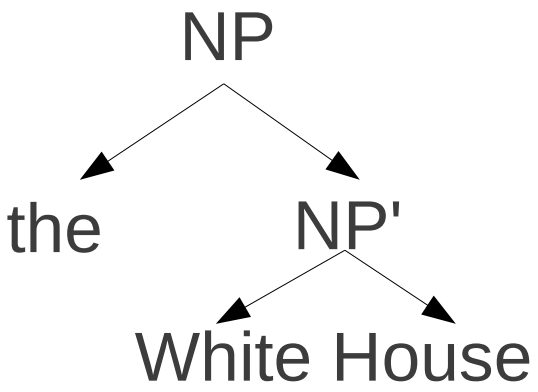
Binarization (En-Ja)

None



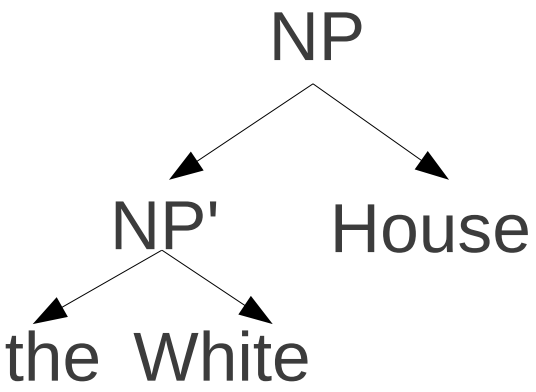
ホワイト ハウス

Right



ホワイト ハウス

Left



ホワイト ハウス

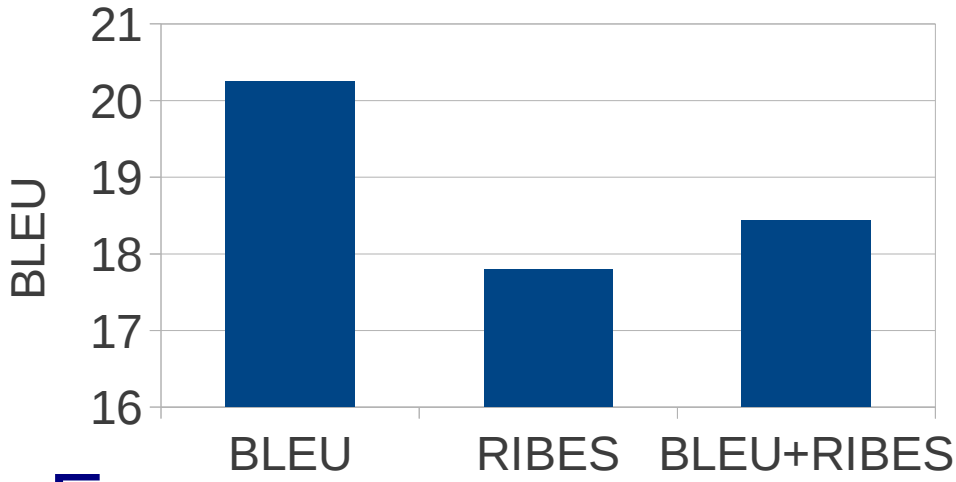
- Right or left much better than none
- In general right > left for En-Ja, left > right for Ja-En

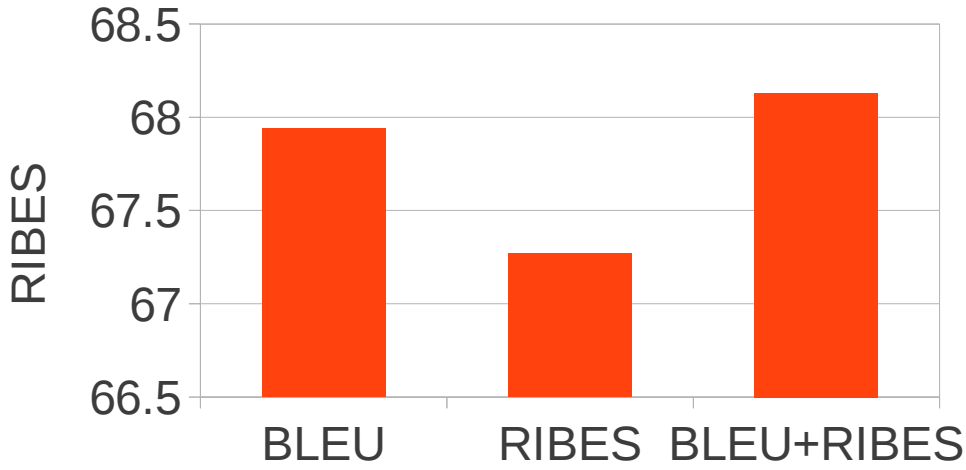
Tuning

- Two evaluation measures:
  - BLEU correlated with fluency
  - RIBES correlated with adequacy
- Tune both of these measures with MERT
- Also, might be worth considering both [Duh+ 12], so we use linear combination BLEU+RIBES also

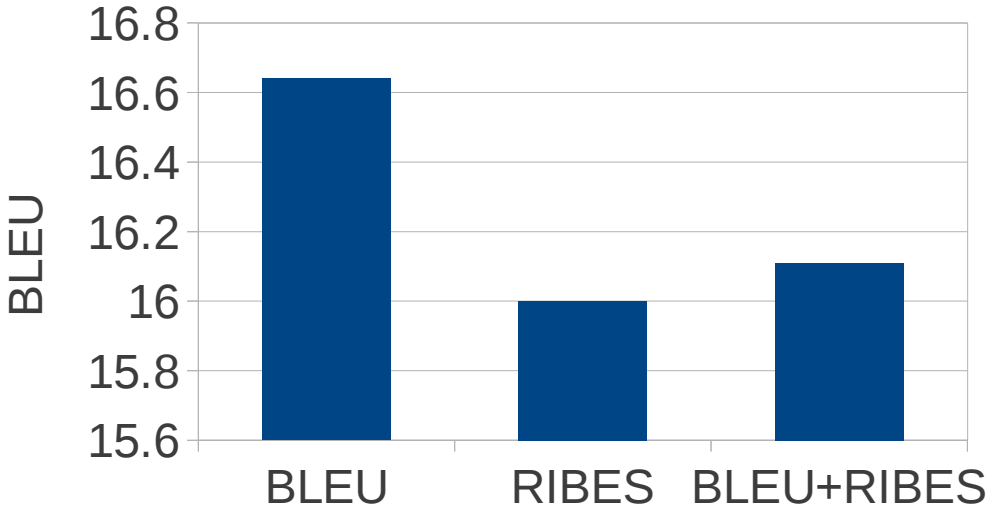
Tuning

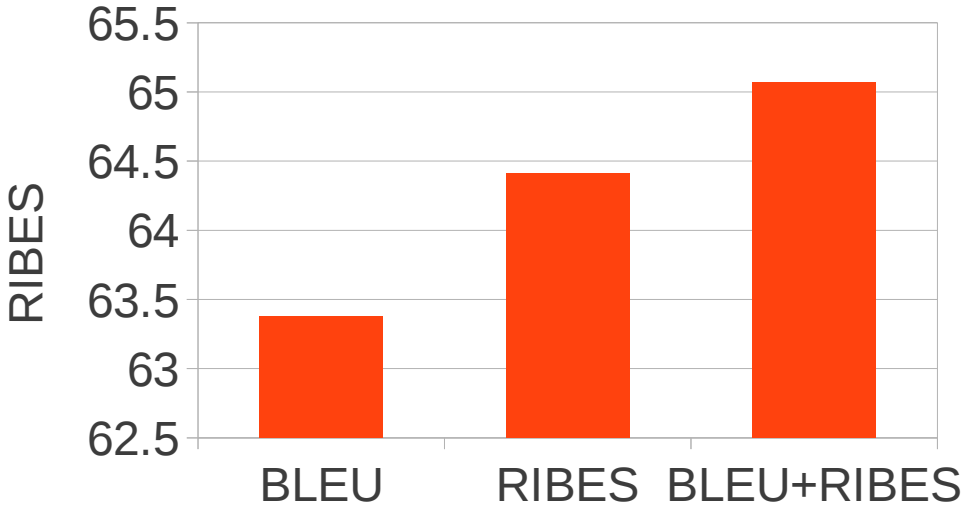
En-Ja





Ja-En





Conclusion

Insights

- How well does tree-to-string work for En-Ja, Ja-En?
  - As well as phrase-based with pre-ordering [Neubig+ 12]
  - Forest-to-string translation works better for En-Ja
- Egret worked best for English-Japanese KyTea+EDA worked the best for Japanese-English
- For Ja-En we need:
  - Better morphological analysis!
  - Pass multiple morphological analysis results to parsing!
  - n-best or forest based parser!

Thank You!