Rule-based Syntactic Preprocessing for Syntax-based Machine Translation

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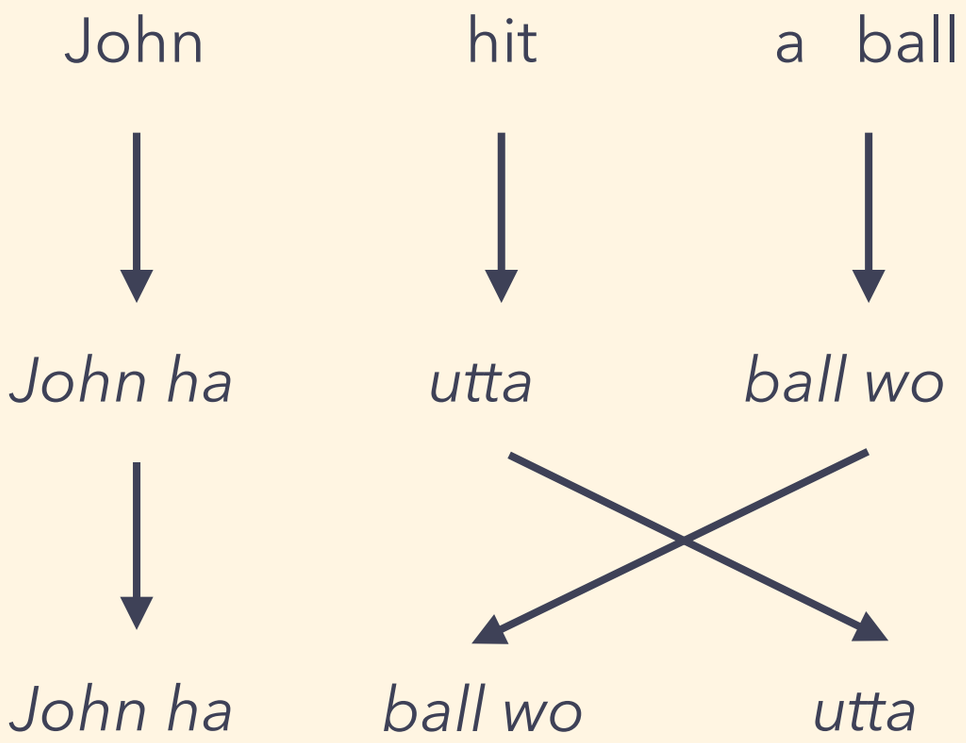
Phrase-based Machine Translation (PBMT)



Translation Model

Reordering Model

- Doesn’t incorporate syntactic information
- Difficulty estimating the probability of long distance reordering

Preprocessing using syntactic information

Lexical Processing for PBMT

Change the words in the sentence

Example: Reduce errors in verb conjugation and noun case agreement

[Avramidis and Koehn, 2008]

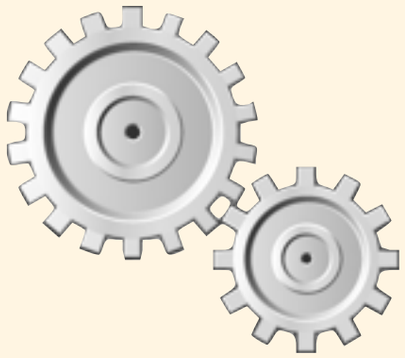
Annotation

[we: nominative] resolved the [issue: dative] of … or [relations: dative] with Serbia

Source language (Tagged)

Target language

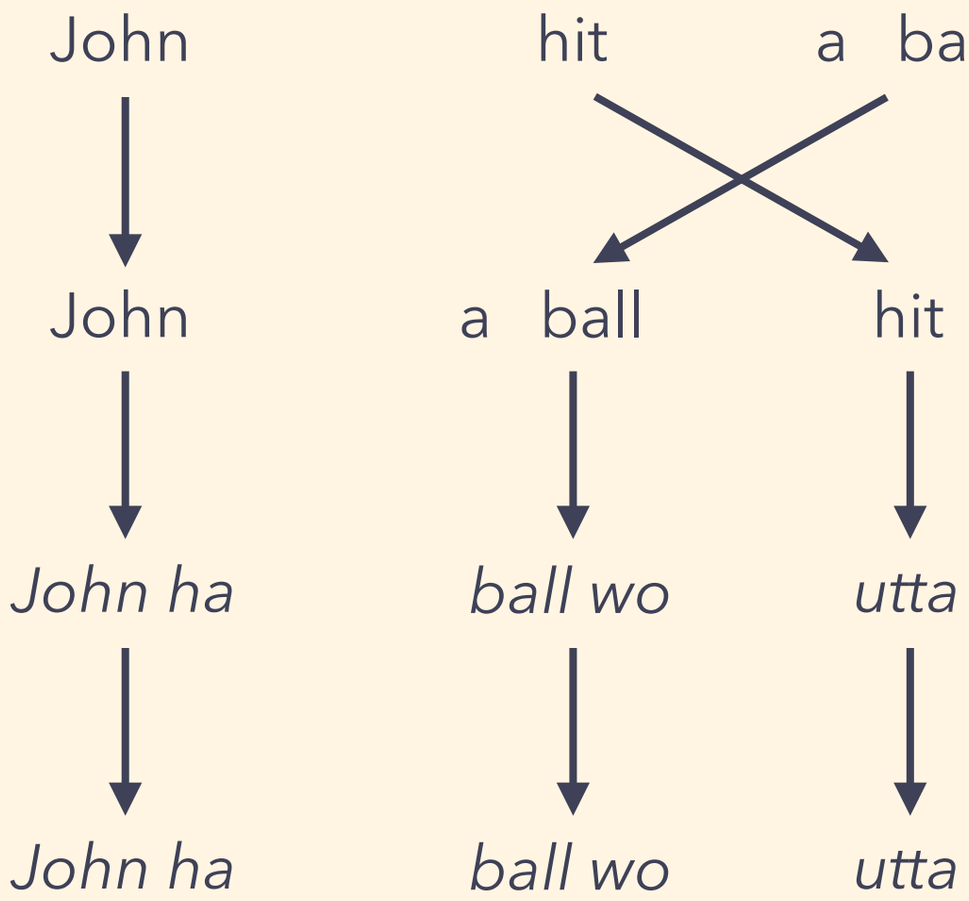
PBMT



Pre-ordering

[Xia and McCord, 2004]

Rearrange source sentence into target language word order



Preordering method

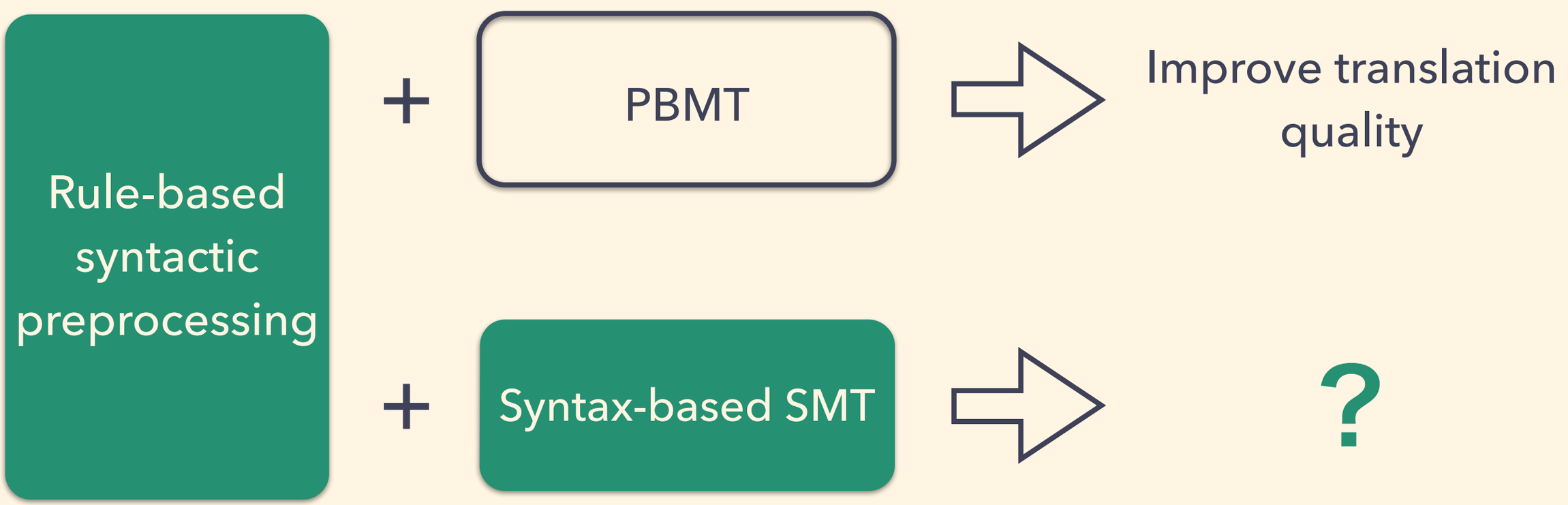
hand-crafted or trained rules

Translation Model

Reordering Model

Motivation

- Rule-based syntactic preprocessing is useful for PBMT
- Few attempts have been made for Syntax-based SMT
- Examine whether it also can contribute to Syntax-based SMT



Head Finalization:
A Syntactic Preprocessing Method for PBMT

Head Finalization

[Isozaki et al., 2010]

- Syntactic preprocessing method for **English to Japanese PBMT**
- Show significant improvements through 2 steps

1

Reordering

Convert English sentence into Japanese word order

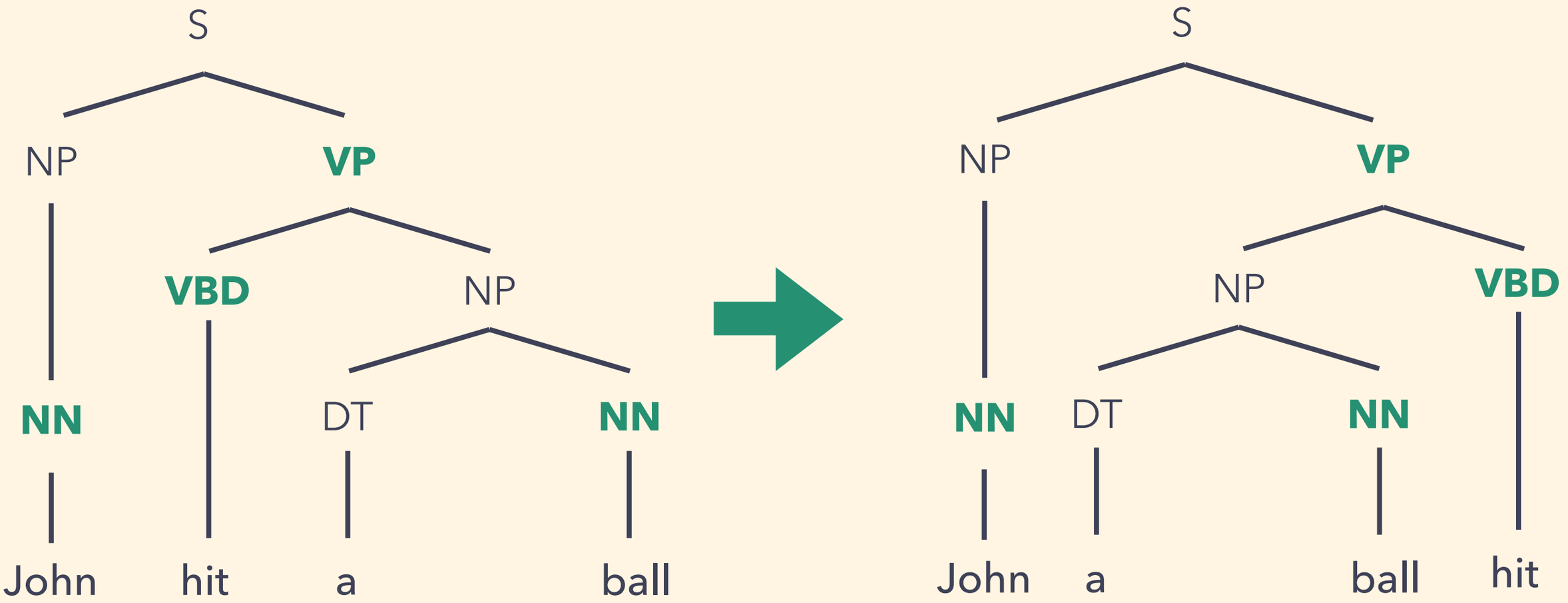
2

Lexical Processing

Generate more Japanese-like sentences

Reordering

1. Move head words to the end of the corresponding syntactic constituents



Reordering

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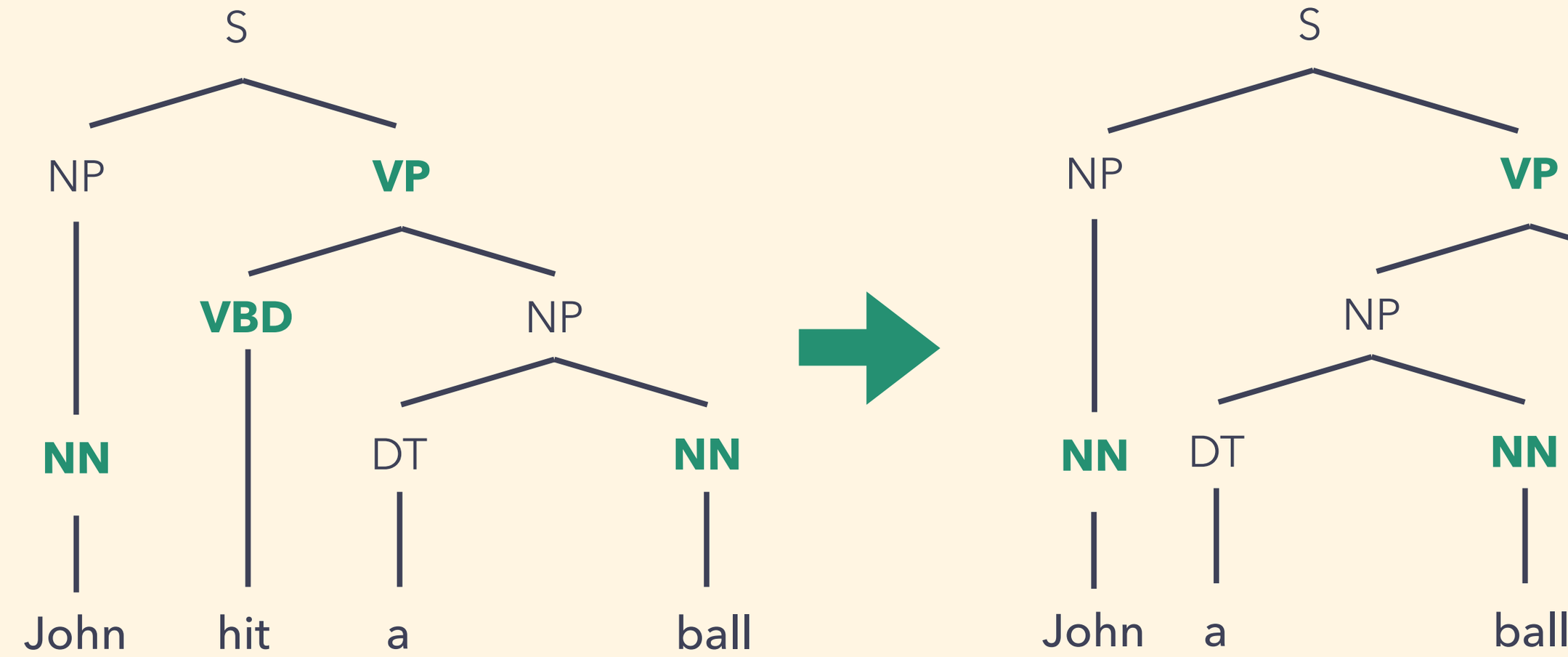


Japanese word order

Lexical Processing

2 Generate sentences closer to Japanese

Determinar elimination / Singularization

John ~~a~~ ball hit

Pseudo-particle insertion

John ***_wa_*** ball ***_wo_*** hit

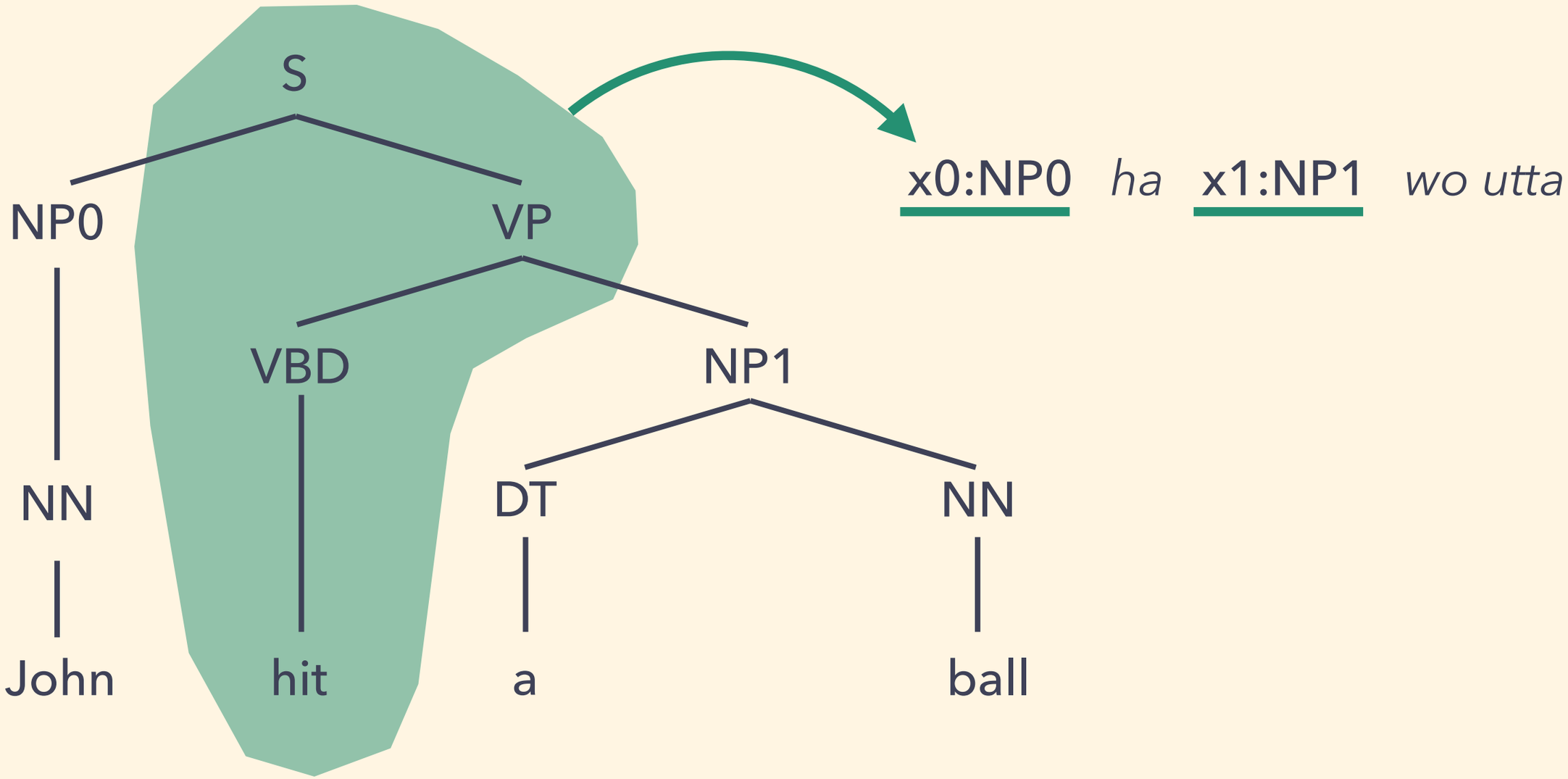
- _wa_ : Subject particle of the main verb
- _ga_ : Subject particle of other verb
- _wo_ : Object particle of any verb

Syntactic Preprocessing for T2S

Tree-to-String machine translation (T2S)

[Liu et al., 2006]

- Use parsing results of the source sentence
  - Possible to generate translations that are more accurate
  - Possible to handle long distance reordering



Potential Effect of Preprocessing on T2S

Reordering

- Improve word alignment
- Identify good translation patterns

Lexical Processing

- Improve translation quality of words

Proposed method

Apply three methods to **T2S**:

1

Reordering

Convert English sentence into Japanese word order

2

Lexical Processing

Determiner elimination / Singularization / Particle insertion

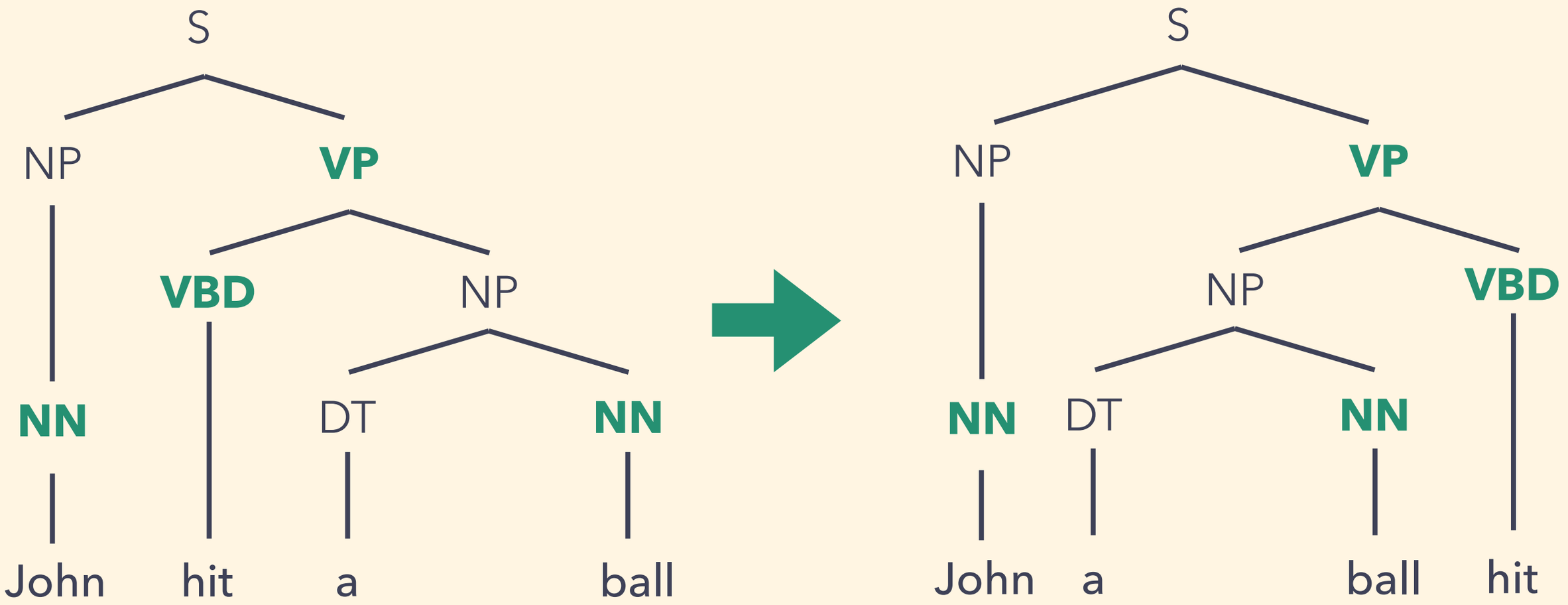
3

HF-feature

Apply reordering information to T2S as soft constraints

Reordering for T2S

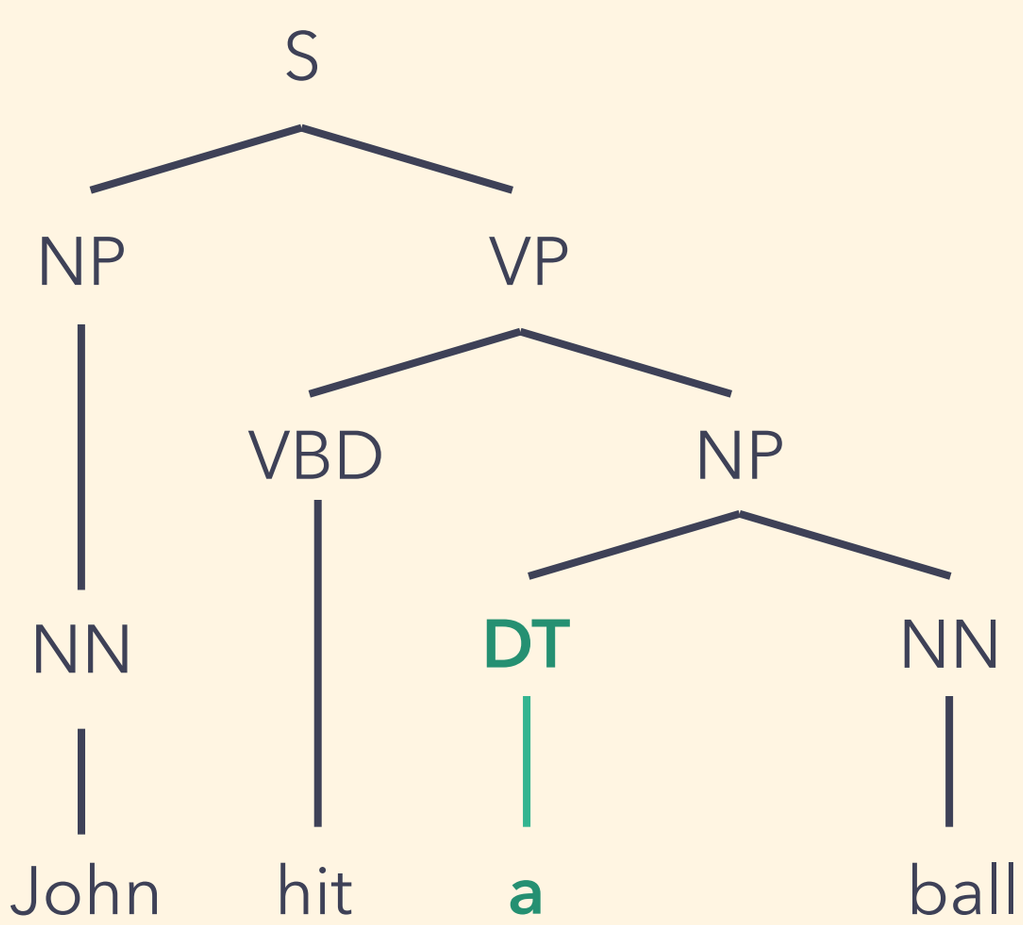
- Convert English sentence into Japanese word order
- Output the reordered tree

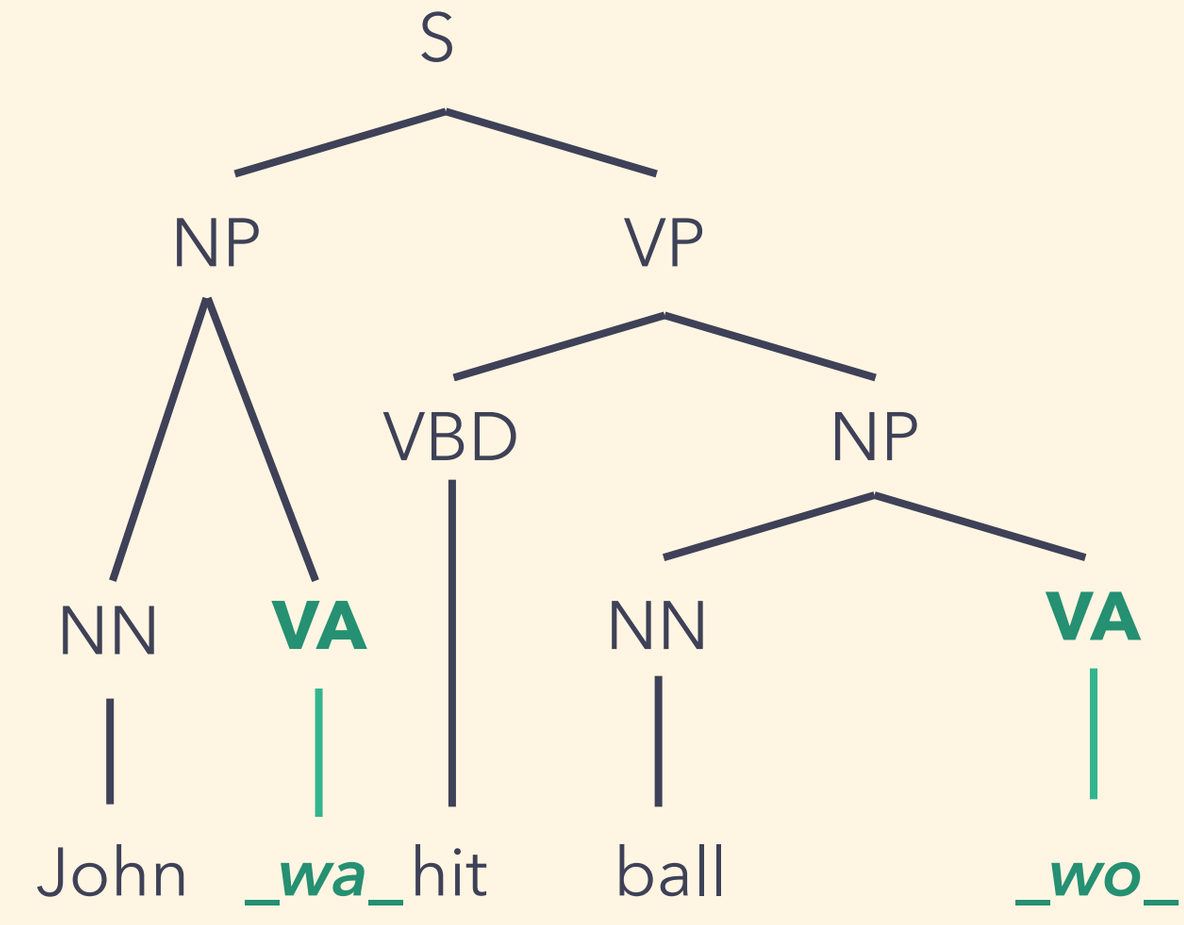


Improve word alignment

Lexical Processing for T2S

- Determinar elimination / Singularization / Particle insertion
- Transform not strings, but trees





Improve translation performance of word

Reordering Information as Soft Constraints

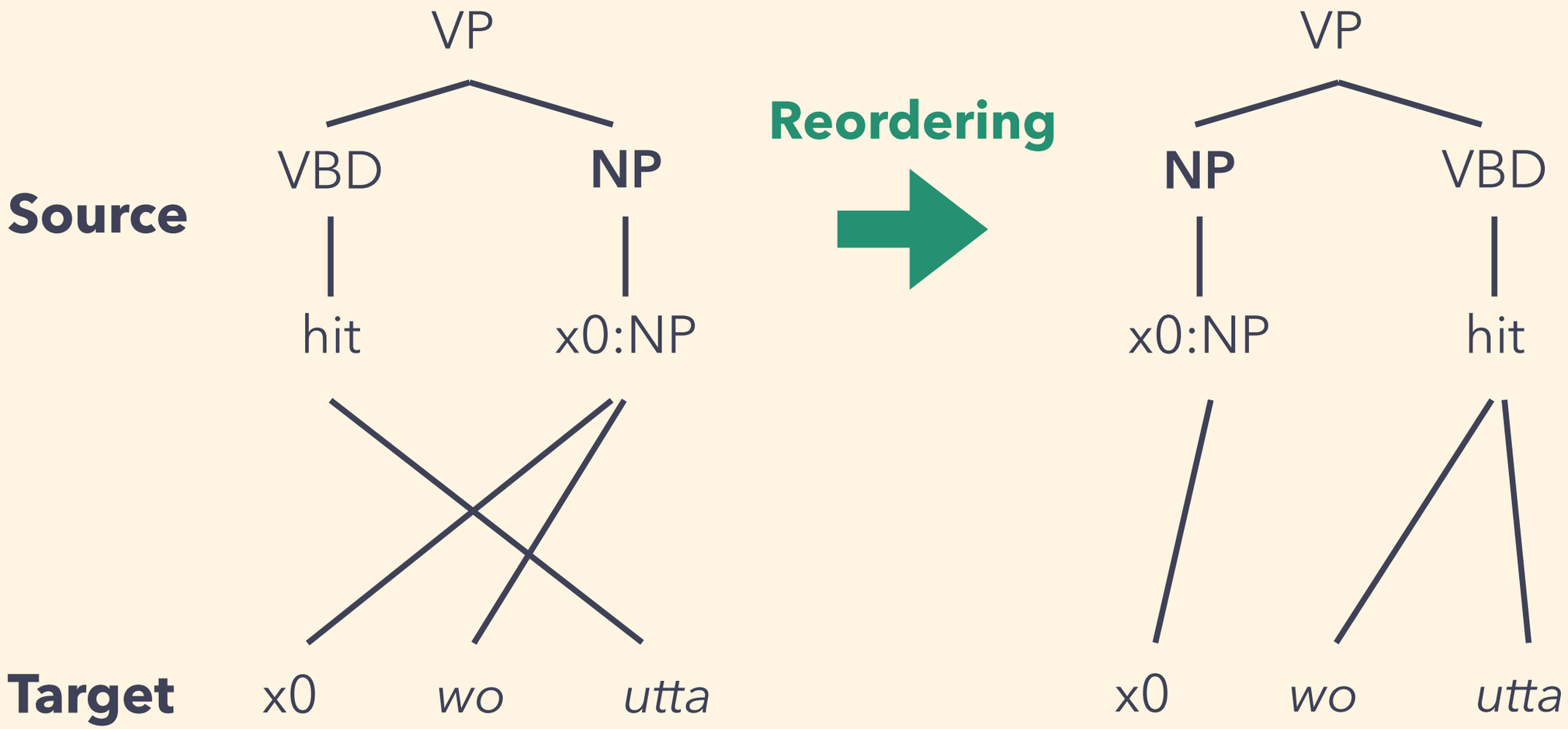
- Some translation patterns do not obey head final order due to bad alignment
- Sometimes head final order is not applicable in Japanese grammar

- Log-linear model

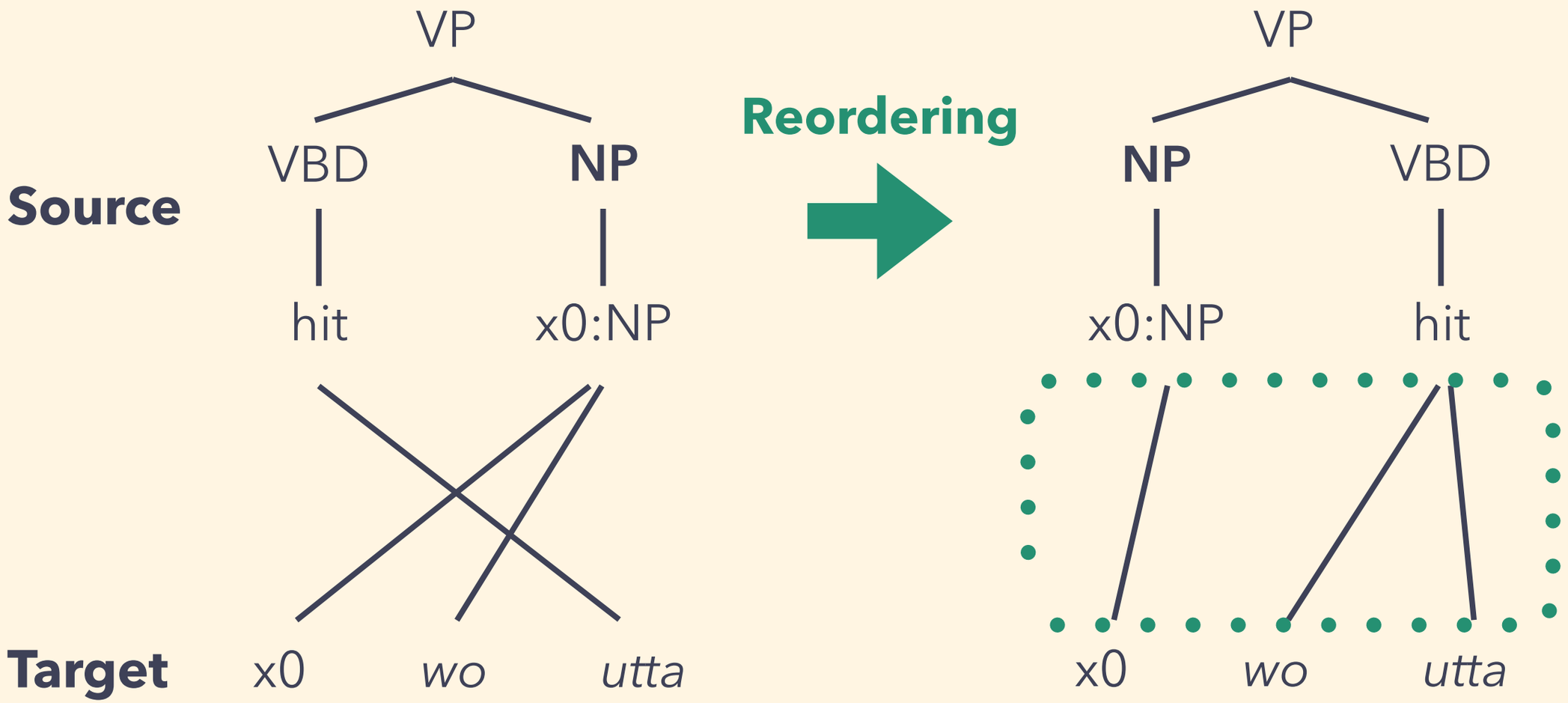
$$\hat{e} = \underset{e}{\operatorname{argmax}}\, \boldsymbol{w}^{\mathrm{T}} \cdot \boldsymbol{h}(\boldsymbol{f}, \boldsymbol{e})$$

$\boldsymbol{f}$	source sentence
$\boldsymbol{e}$	target sentence
$\boldsymbol{h}(\cdot)$	feature function

Procedure of HF-feature addition



Procedure of HF-feature addition



Non-crossing $h_{\mathrm{HF}}(\boldsymbol{f}, \boldsymbol{e}) = 1$

Crossing $h_{\mathrm{HF}}(\boldsymbol{f}, \boldsymbol{e}) = 0$

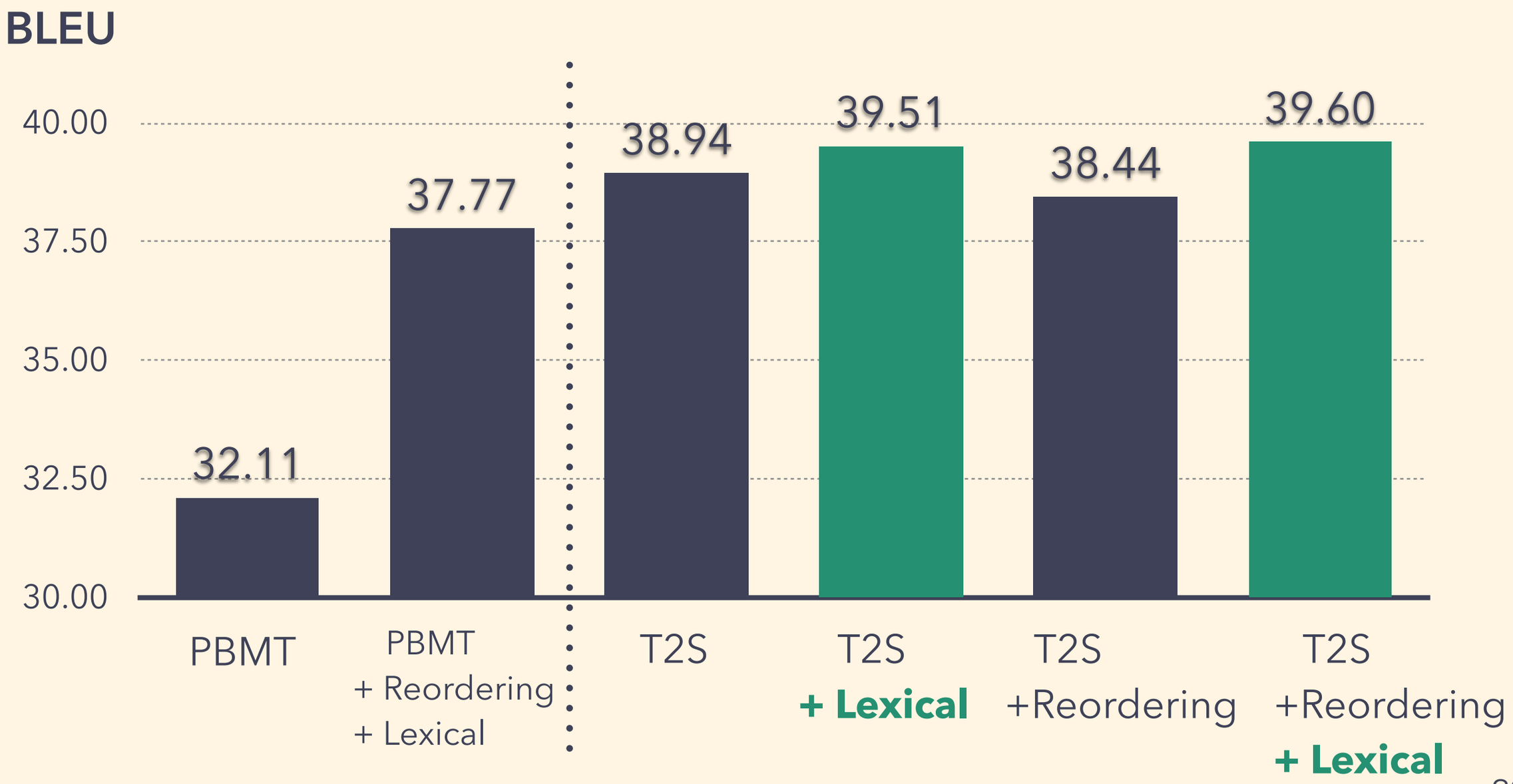
Experiment and Result

Experimental Environment

- Translation Task
  - English → Japanese
  - NTCIR-7 (train: 3.08M, dev: 0.82k, test: 1.38k sentences)
- Translation Method
  - PBMT (default settings of moses)
  - T2S (default settings of travatar)
- Evaluation
  - BLEU, RIBES

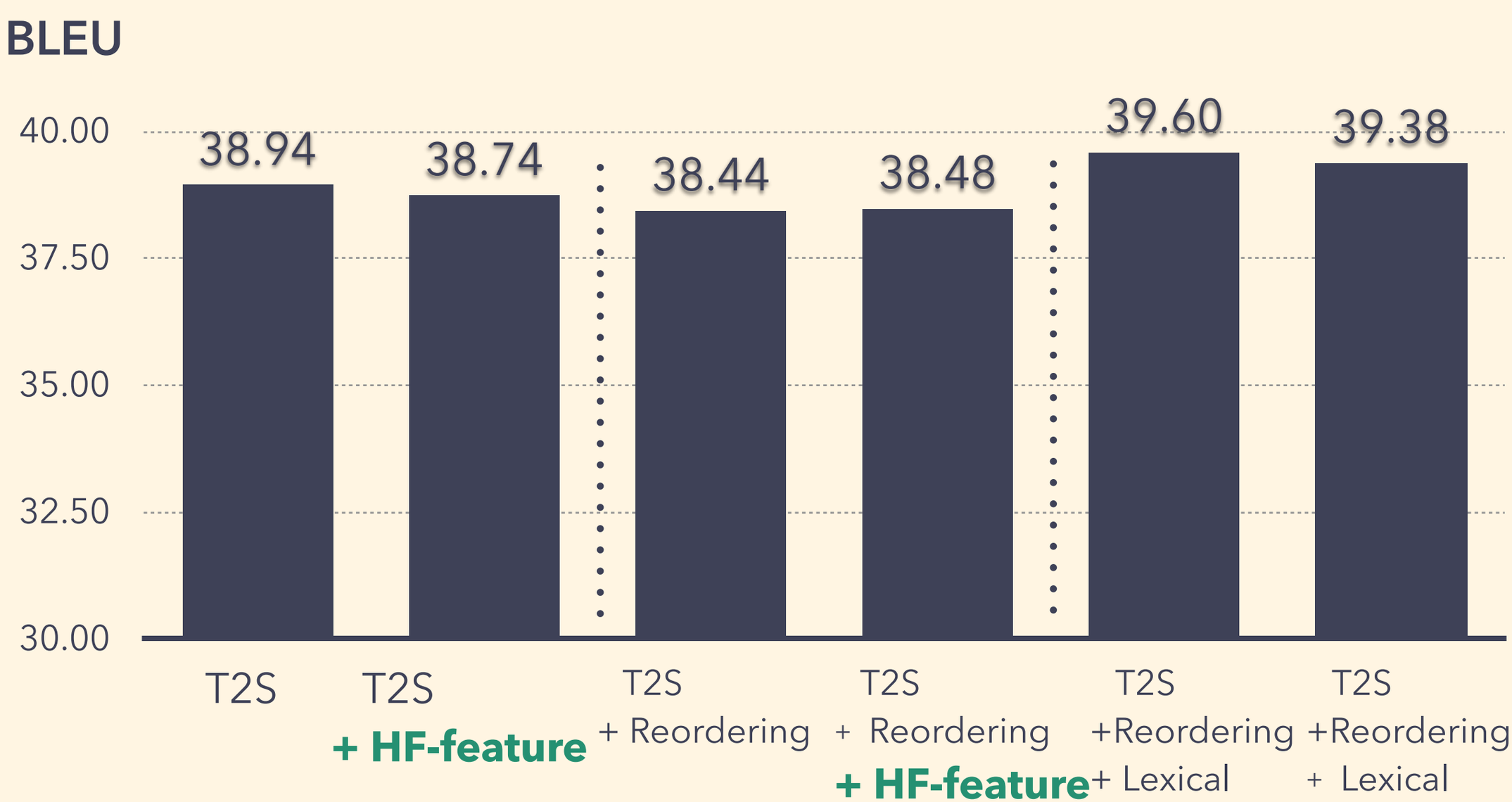
Translation quality

- Translation quality is improved by Lexical Processing
- Reordering is not effective for T2S



Translation quality

- Translation quality is not improved by HF-feature
  - Reordering quality achieved by T2S was already high



Conclusion and Future Work

- Applied rule-based syntactic preprocessing designed for PBMT to T2S

Reordering +

Lexical Processing +

Reordering feature ⇨

- Examine other language pairs / Apply preprocessing to F2S

Improvement by Lexical Processing

◉ - Lexical Processing

図 に 示 す よう に 、 電気 絶縁 性 の ハウジング ９７に 一 列 に 並 ぶ 複数 の 雄型 コンタクト ９８ と から 構成 され て い る 。

s (x0:np vp (pn (, (“,”)) vp (vx (vbz (“comprises”)) x1:np)))

→ x0 x1 “と” “から” “構成” “さ” “れ” “て” “い”

◉ + Lexical Processing

図 に 示 す よう に 、 電気 絶縁 性 の ハウジング ９７に 一 列 に 並 ぶ 複数 の 雄型 コンタクト ９８ を 有 し て 構成さ れ る 。

np (np (x0:nx) va (_va2 “_va2”)) → x0 “を”

Optimized weight of HF-feature

- HF-feature led to confusion in MERT optimization
- There is no consistent pattern of learning weights

HF-feature	Reordering	Lexical	Weight of HF-feature
–	–	–	-0.00707078
–	–	+	0.00524676
–	+	–	0.156724
–	+	+	-0.121326

Translation Quality

			PBMT		T2S	
HF-feature	Reordering	Lexical	BLEU	RIBES	BLEU	RIBES
–	–	–	32.11	69.06	38.94	78.48
–	–	+	33.16	70.19	**39.51**	**79.47**
–	+	–	37.62	77.56	38.44	78.48
–	+	+	37.77	77.71	**39.60**	**79.26**
+	–	–	–	–	38.74	78.33
+	–	+	–	–	**39.29**	**79.23**
+	+	–	–	–	38.48	78.44
+	+	+	–	–	**39.38**	**79.21**