Learning to translate with source and target syntax

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Overview

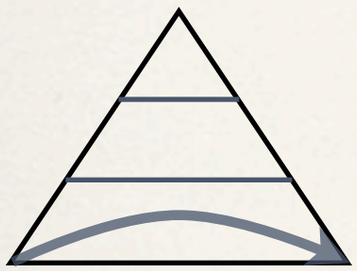
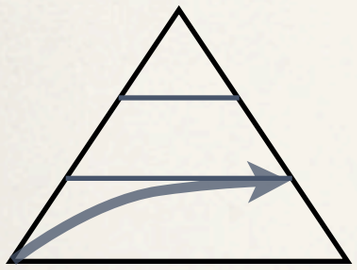
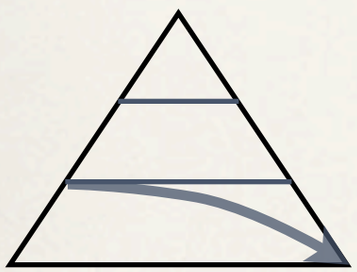
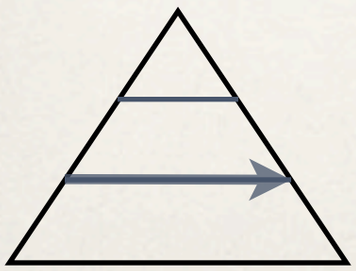
- Using source and target syntax
- Why is it hard?
- How can we make it better?
  - Let the model learn how much syntax to use
  - The model does choose syntax, for improvements of +0.6–0.8 BLEU

reference: An official from Japan ’s science and technology ministry said , " We are highly encouraged by Abraham ’s comment .

Hiero: Officials of the Japanese ministry of education and science , " said Abraham speeches , we are deeply encouraged by .

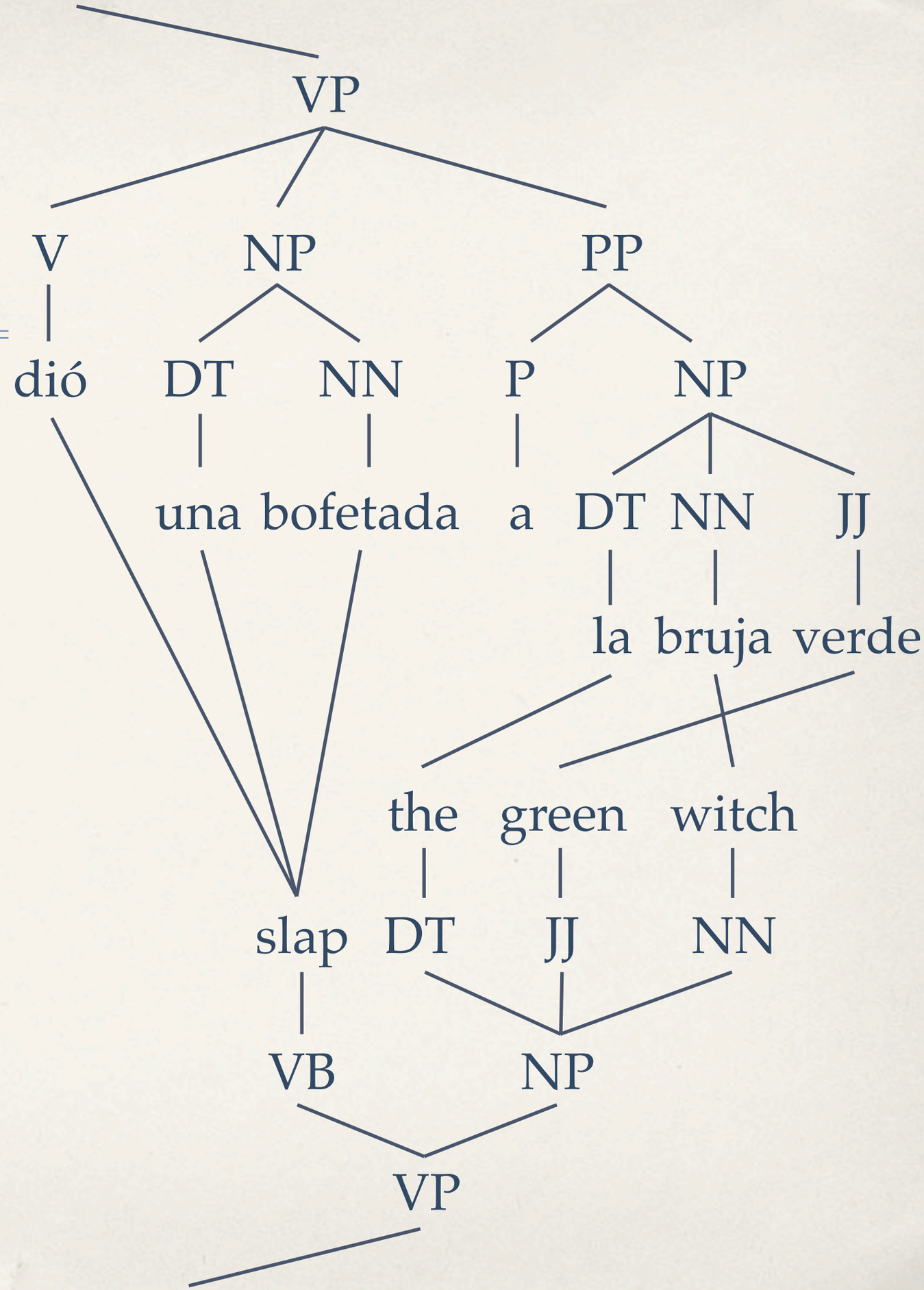
string-to-tree: Japan ’s ministry of education , culture , sports , science and technology , " Abraham ’s statement , which is most encouraging , " the official said .

Previous work

	string-to-string	ITG (Wu 1997)	Hiero (Chiang 2005)
	string-to-tree	Yamada & Knight 2001	Galley et al 2004/2006
	tree-to-string		Huang et al 2006 Y Liu et al 2006
	tree-to-tree	DOT (Poutsma 2000) Eisner 2003	Stat-XFER (Lavie et al 2008) M Zhang et al. 2008 Y Liu et al., 2009

STSG extraction

1. Phrases
   - respect word alignments
   - are syntactic constituents on *both* sides
2. Phrase pairs form rules
3. Subtract phrases to form rules



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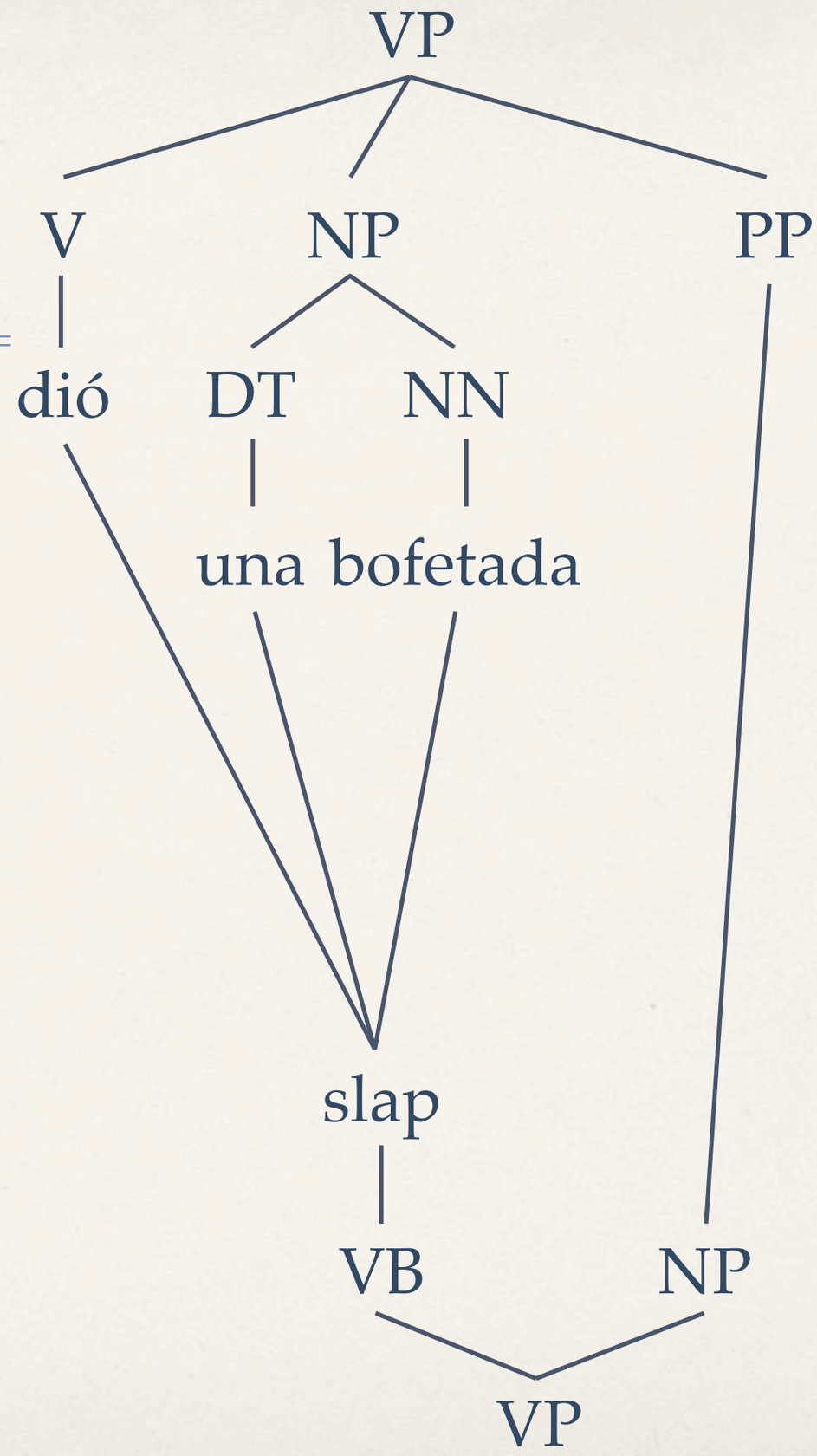


STSG translation

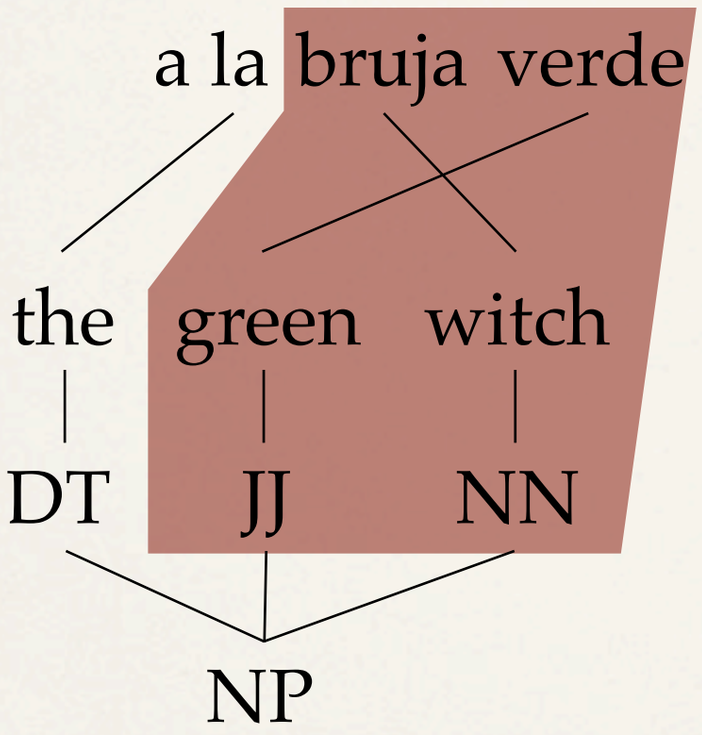
Liu et al, 2009	
phrase	23.66
STSG	20.21

Zhang et al, 2008	
phrase	23.86
STSG	24.71

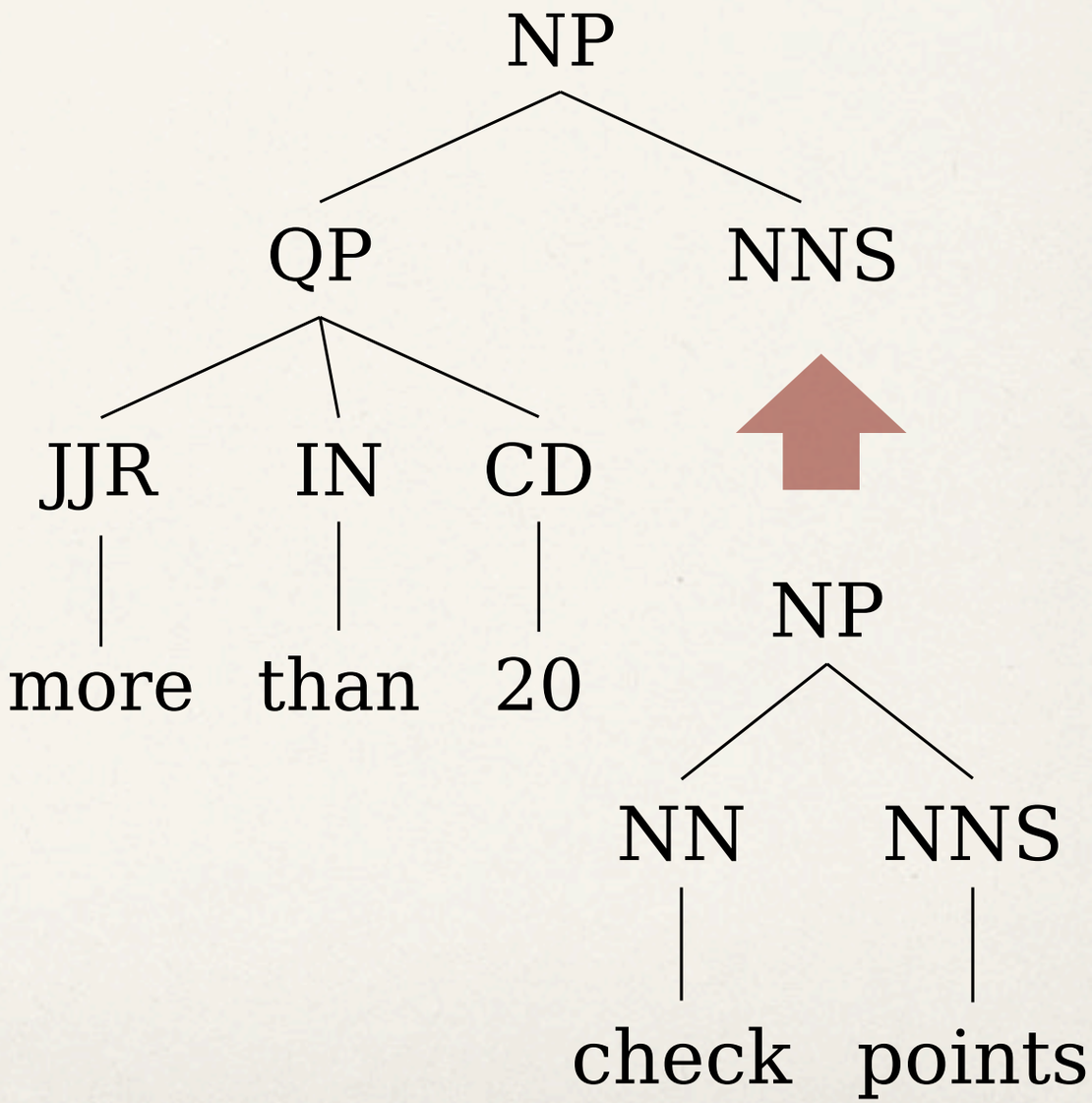
Ambati and Lavie, 2008	
phrase	30.18
STSG	22.23

Why is tree-to-tree hard?

too few rules



too few derivations



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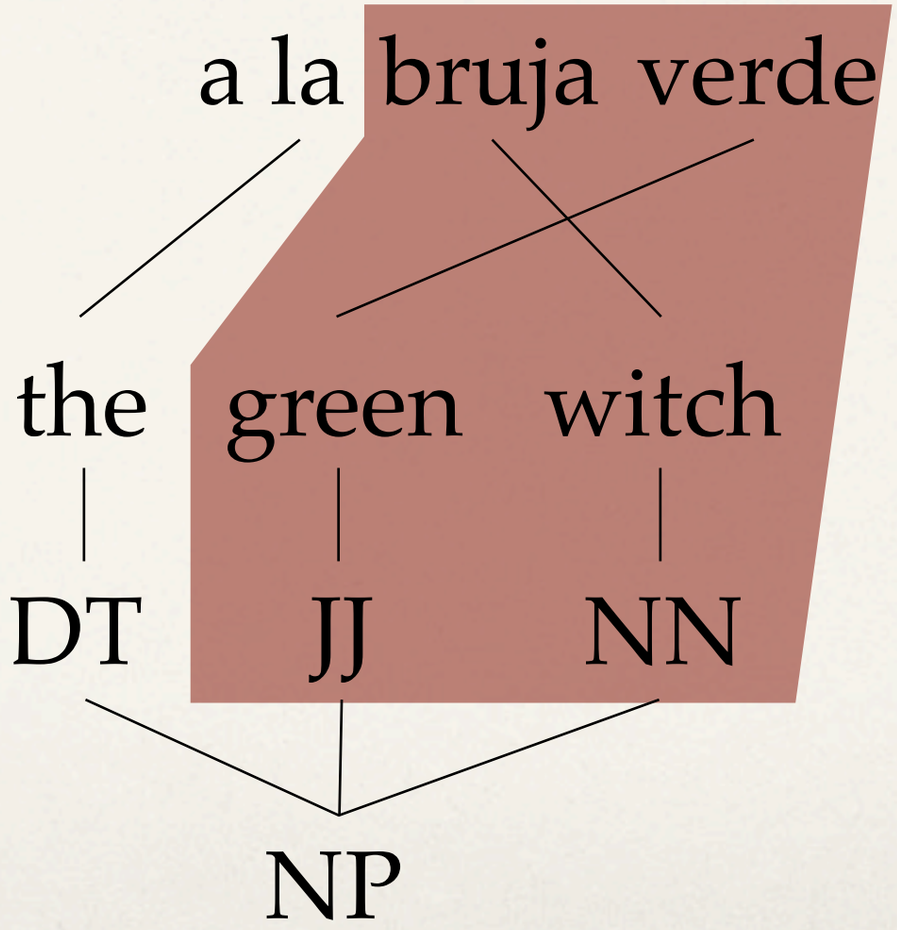
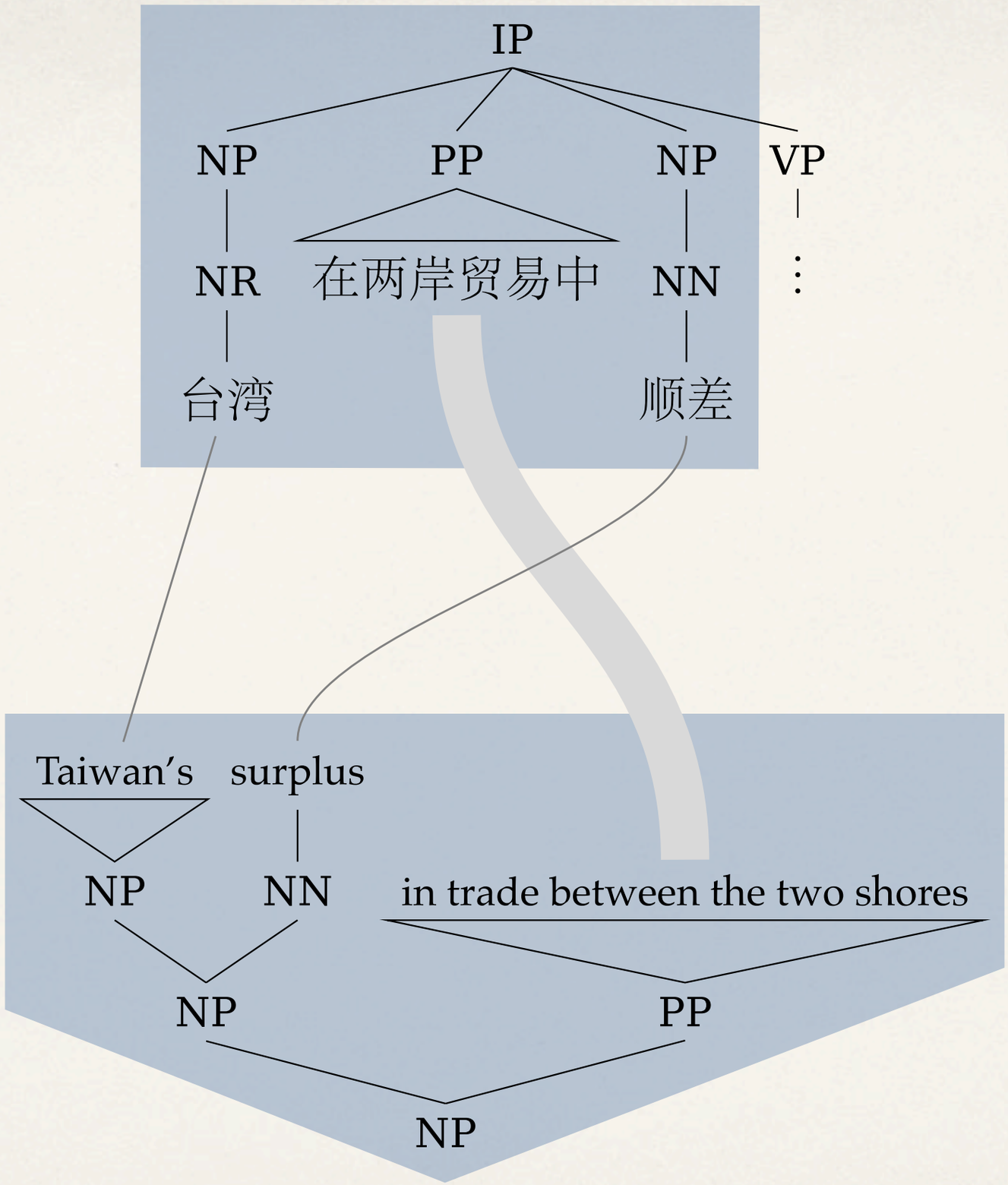



IP
NP
PP
NP
VP
NR
在两岸贸易中
NN
台湾
顺差
Taiwan's
surplus
NP
NN
in trade between the two shores
NP
PP
NP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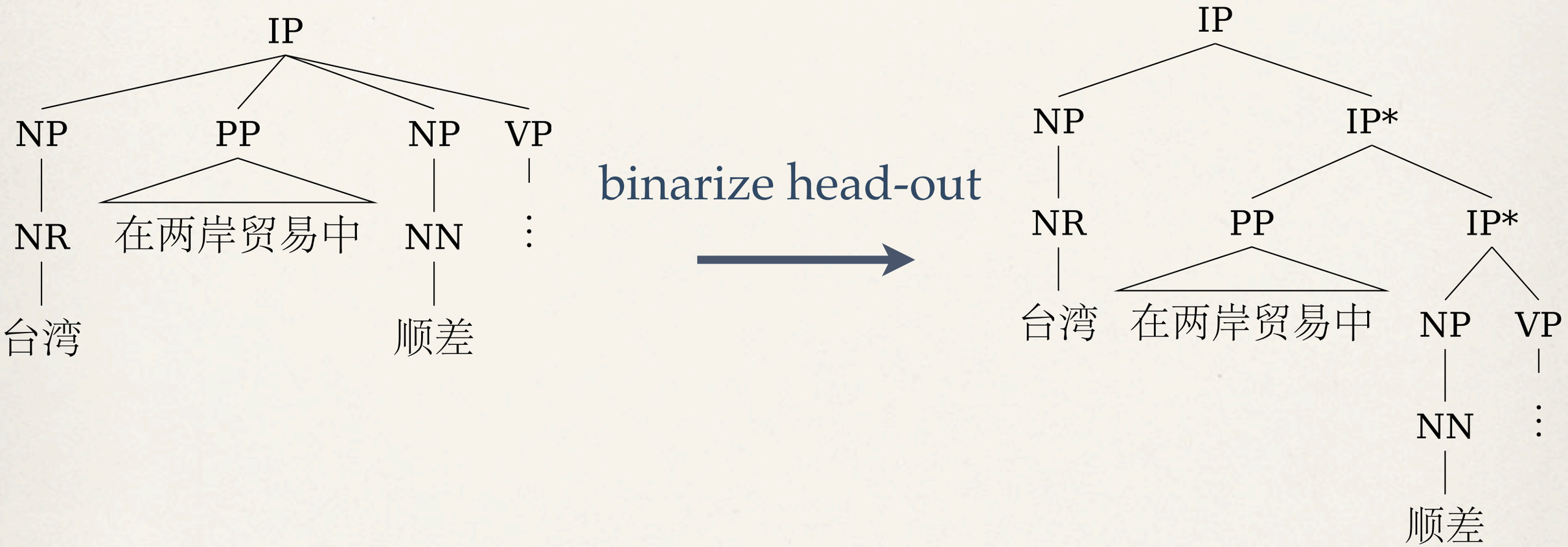
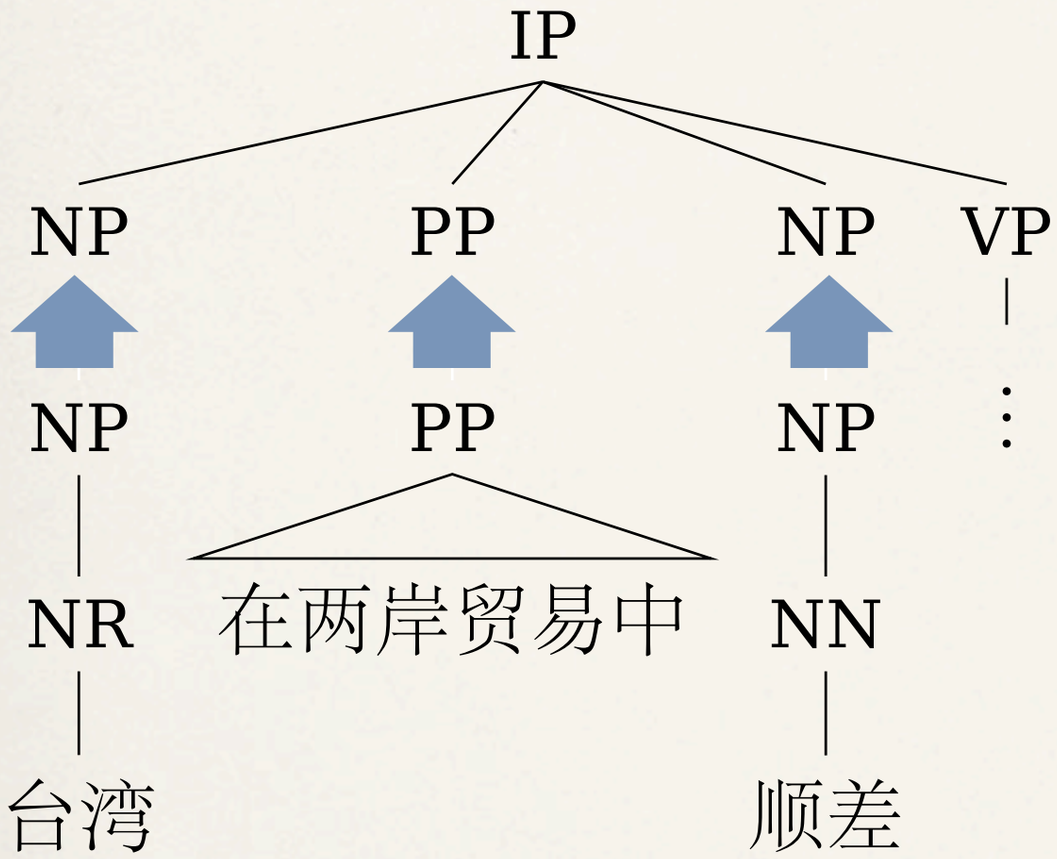
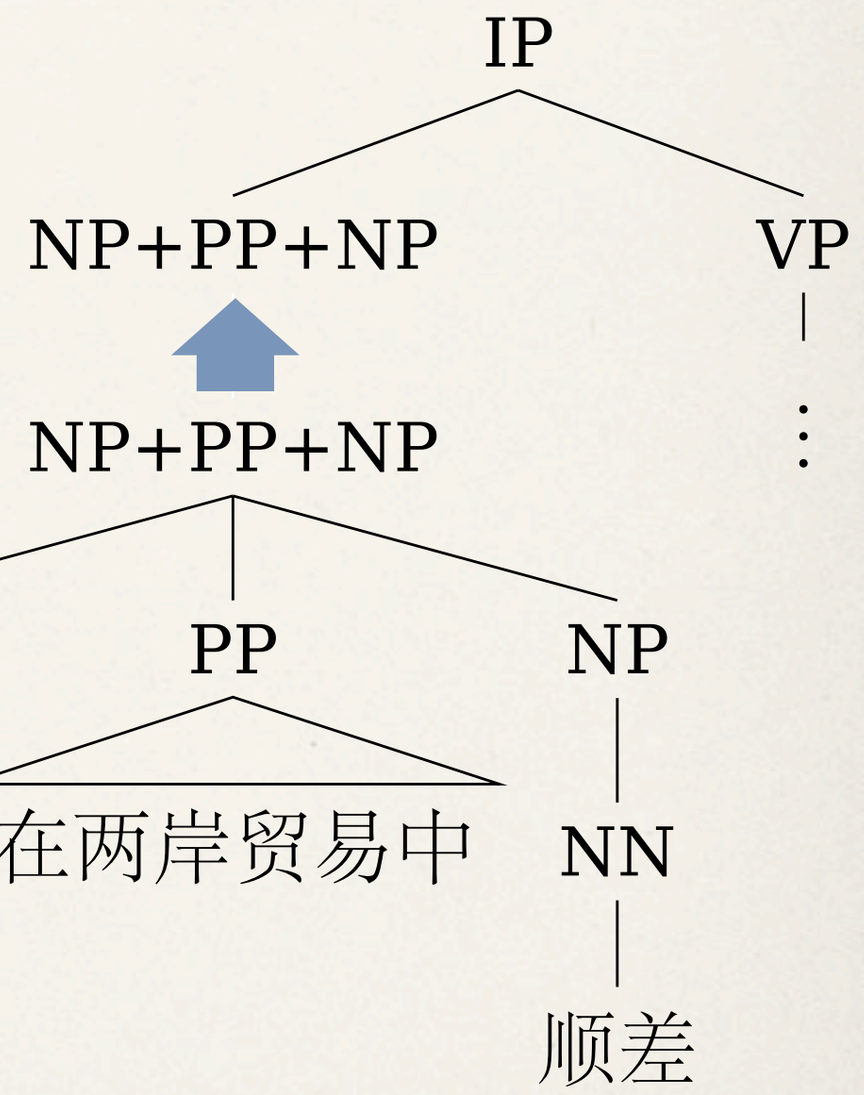
Extracting more rules



Extracting more rules



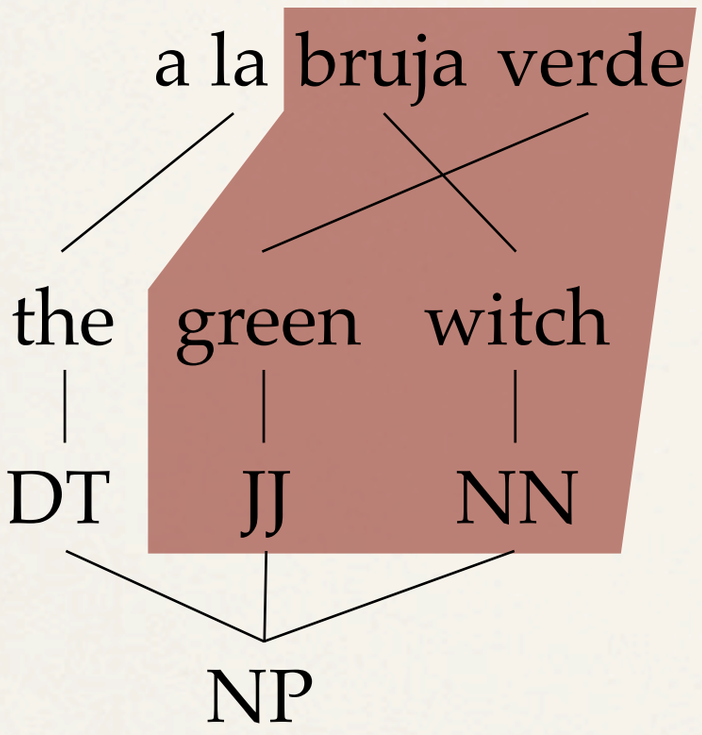
Tree-Sequence Substitution Grammar (M. Zhang et al., 2008)



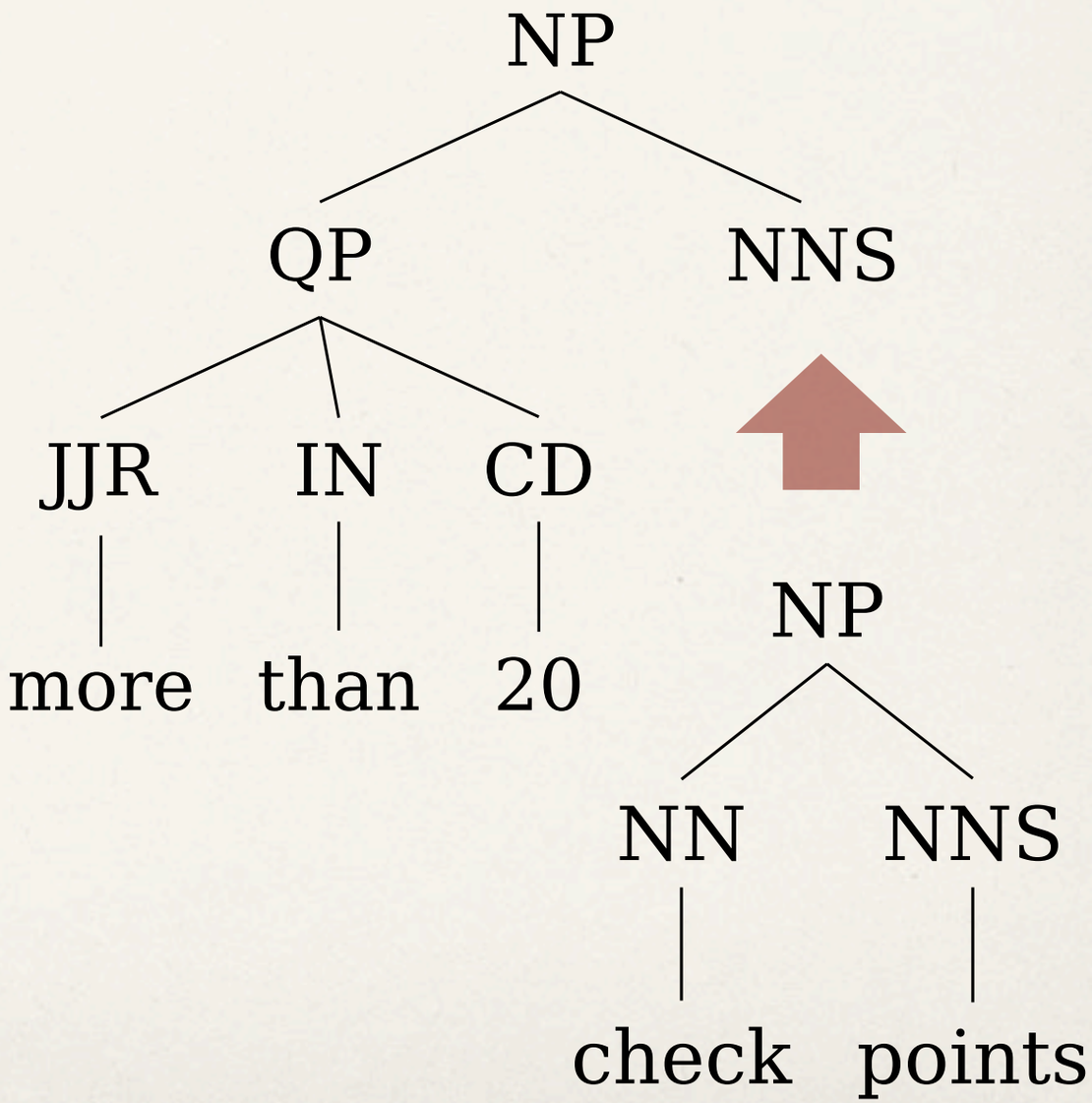
Syntax-Augmented Machine Translation (Venugopal & Zollmann)

Why is tree-to-tree hard?

too few rules

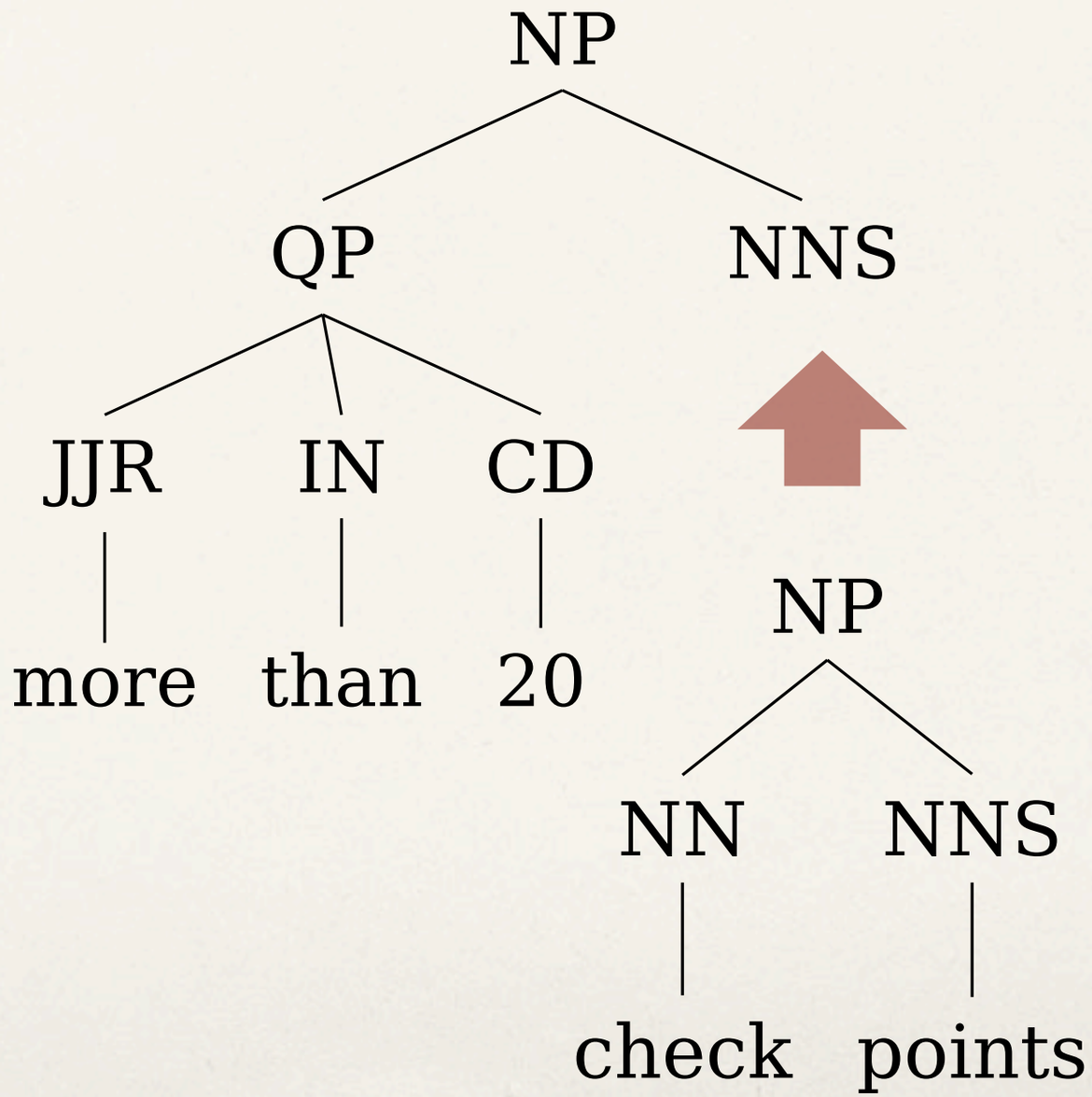


too few derivations

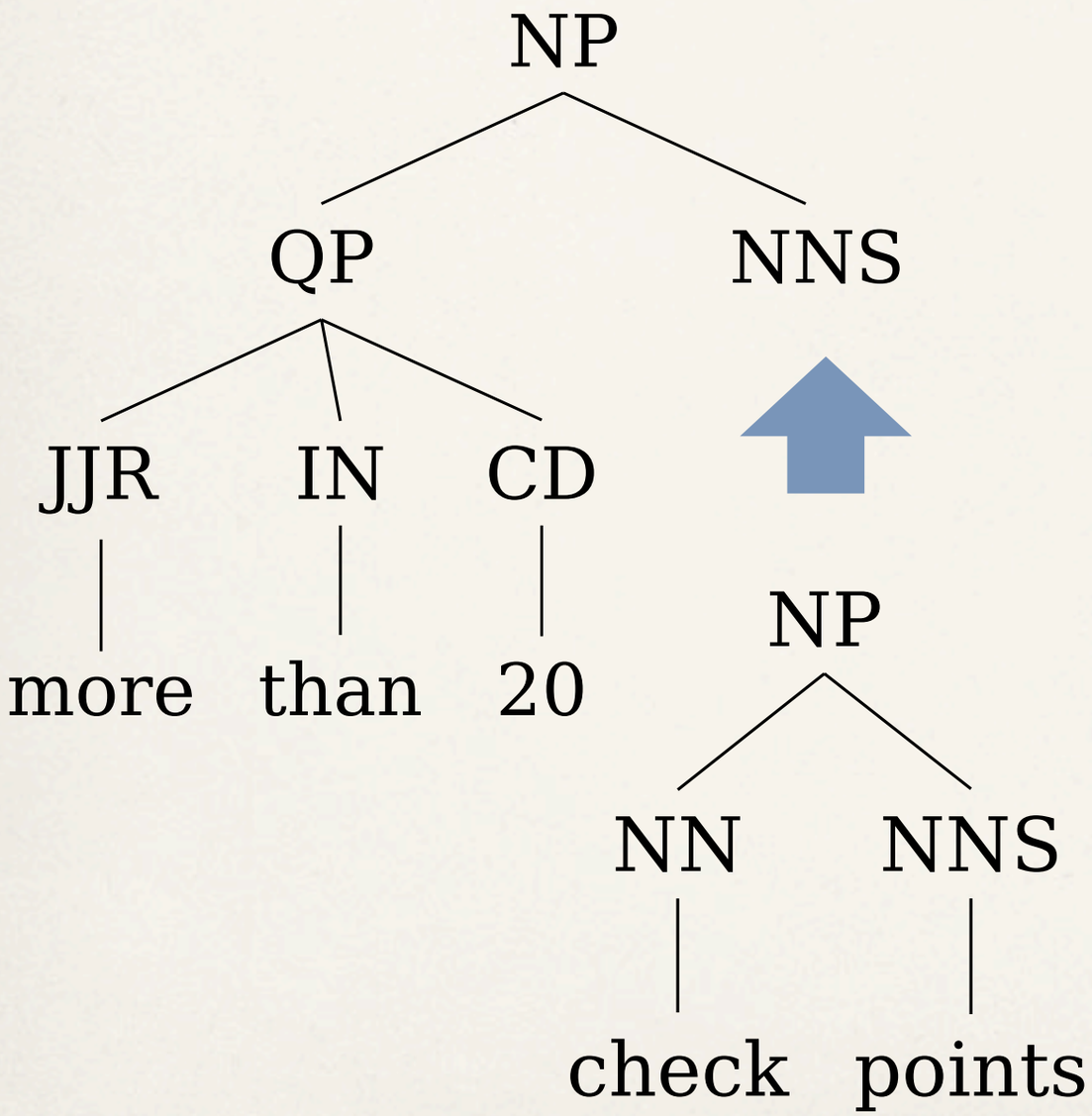


Why is tree-to-tree hard?

too few derivations

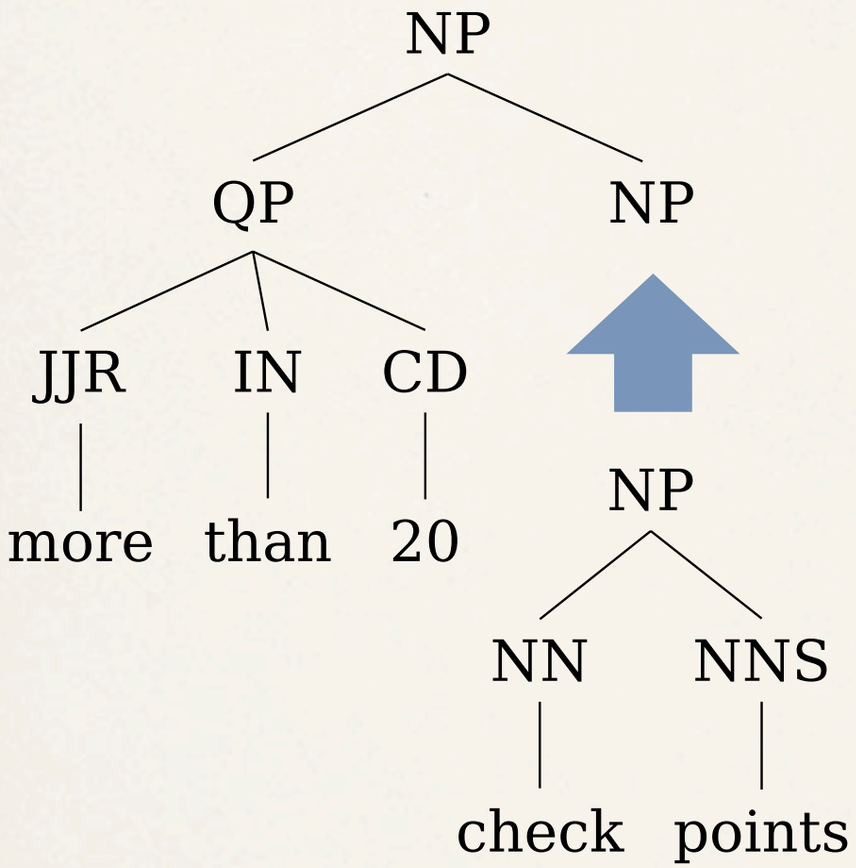


Allow more derivations



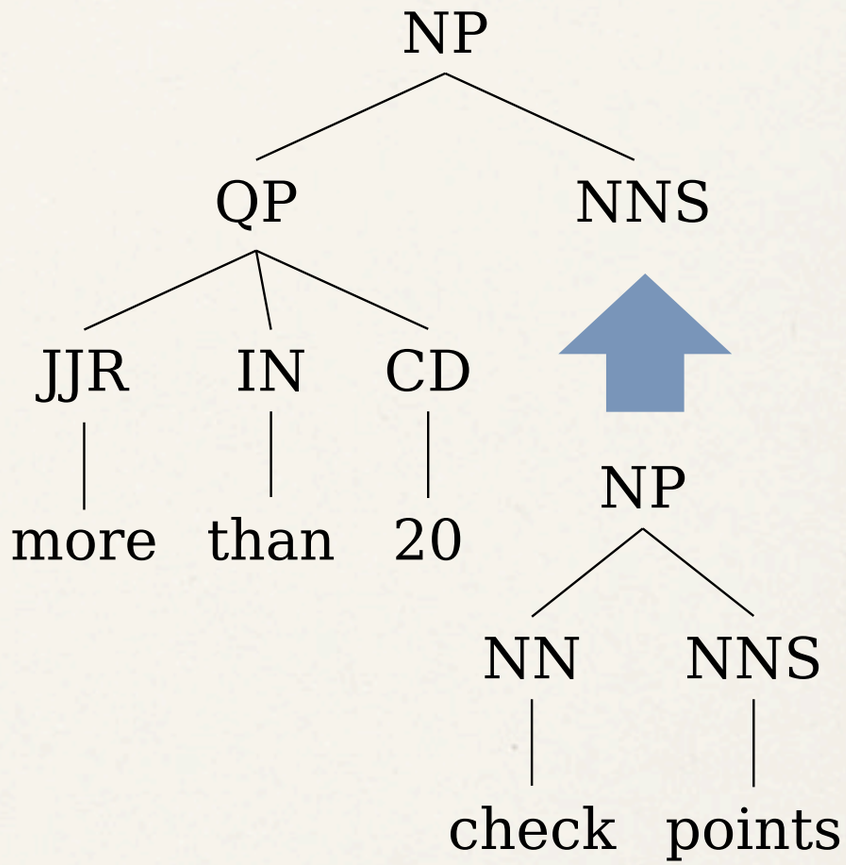
- STSG: allow only matching substitutions
- Hiero-like: allow any substitutions
- Let the model learn to choose:
  - matching substitutions
  - mismatching substitutions
  - monotone phrase-based

Allow more derivations



fire *subst*:NP→NP

fire *subst:match*

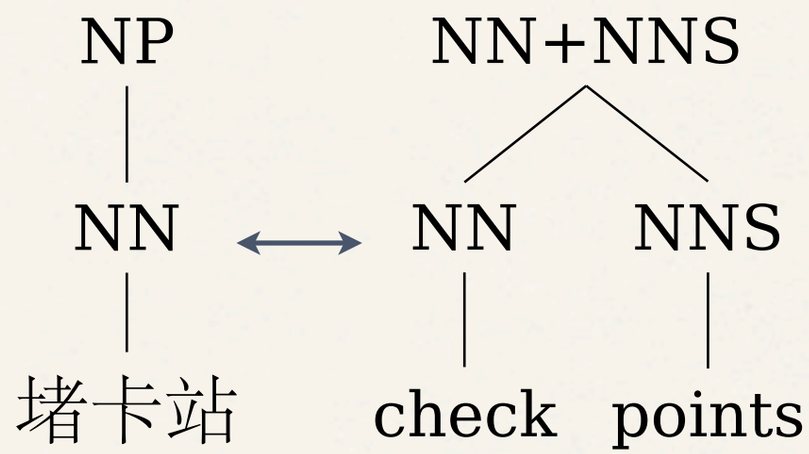


fire *subst*:NNS→NP

fire *subst:unmatch*

Allow more derivations

Cross-lingual features



fire *root*:NP,NN+NNS

suggested by Adam Pauls

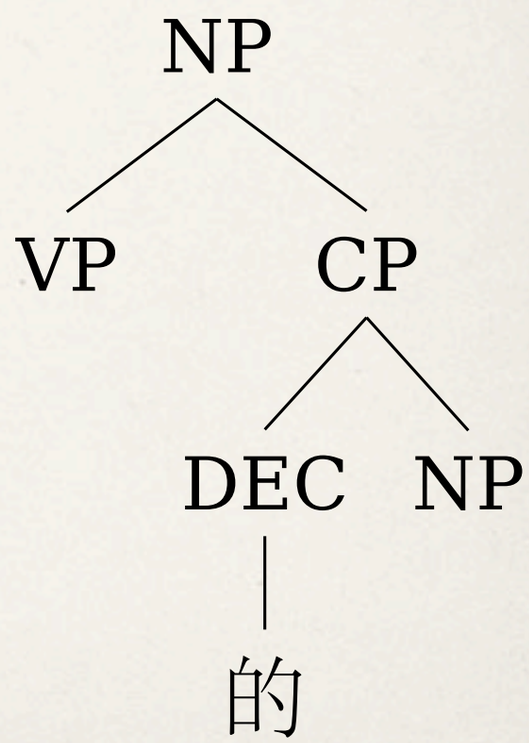
Allow more derivations

Hiero-like decoding

$$\frac{[X,i,j] \qquad [X,j+1,k]}{[X,i,k]} \qquad X \rightarrow X \text{ 的 } X$$

STSG decoding

$$\frac{[VP,i,j] \qquad [NP,j+1,k]}{[NP,i,k]}$$



fuzzy STSG decoding

$$\frac{[A,i,j] \qquad [B,j+1,k]}{[NP,i,k]}$$

Experiments

	Chinese-English	Arabic-English
parallel text	240M+260M	190+220M
language model	2G	
parser (source)	800k	600k
parser (target)	2.1M	

Results

	Chinese-English			Arabic-English		
extraction	rules	feats	BLEU	rules	feats	BLEU
Hiero	440M	1k	23.7	790M	1k	48.9
fuzzy STSG	50M	5k	23.9	38M	5k	47.5
fuzzy STSG +binarize	64M	5k	24.3	40M	6k	48.1
fuzzy STSG +SAMT	440M	160k	24.3	790M	130k	49.7

Example tree-to-tree translation

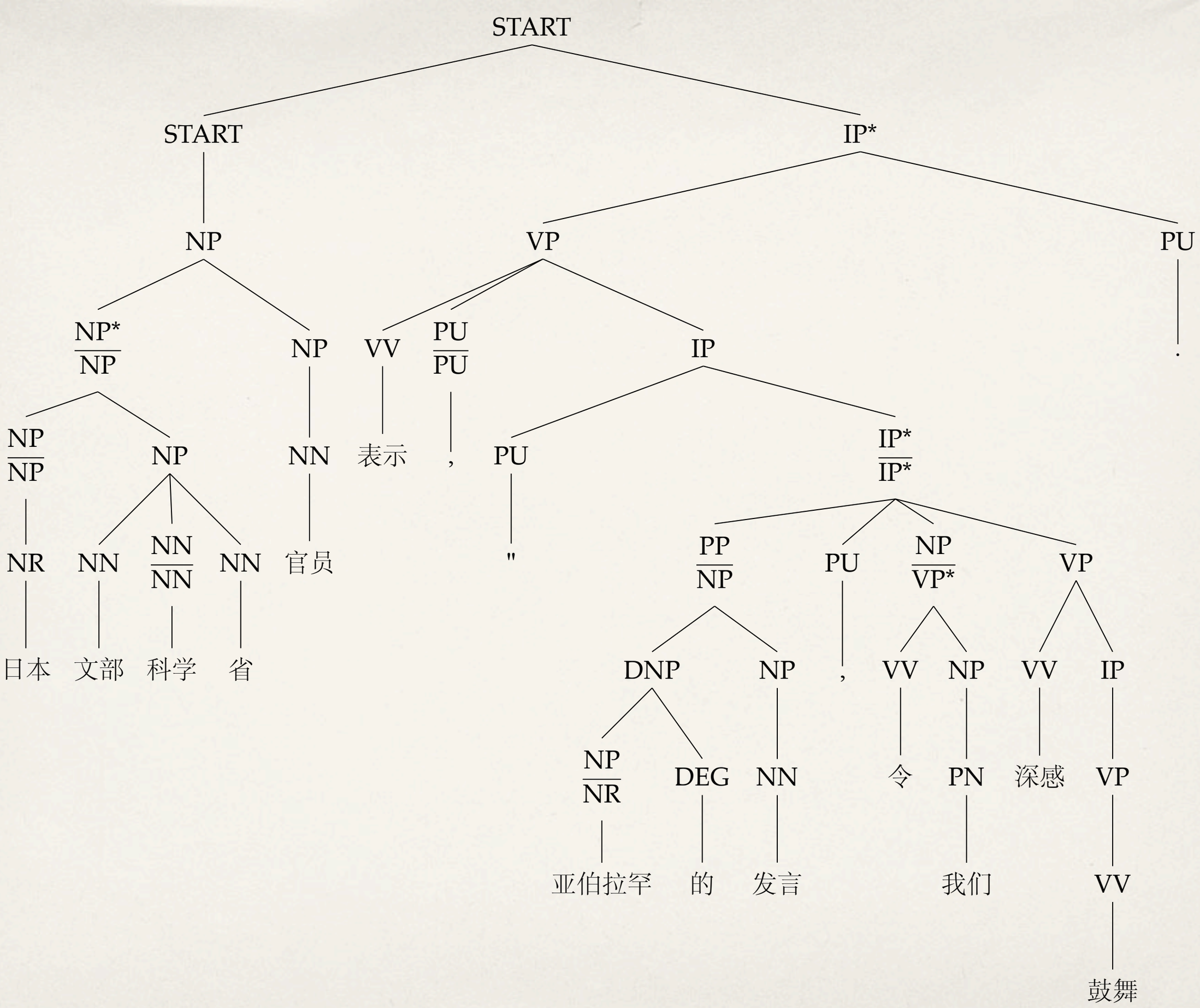
日本 文部 科学 省 官员 表示 , " 亚 伯拉罕 的 发言 , 令 我们 深感 鼓舞
Japan MEXT official said , “ Abraham ’s comment make us deeply-feel courage

reference: An official from Japan ’s science and technology ministry said , " We are highly encouraged by Abraham ’s comment .

Hiero: Officials of the Japanese ministry of education and science , " said Abraham speeches , we are deeply encouraged by .

string-to-tree: Japan ’s ministry of education , culture , sports , science and technology , " Abraham ’s statement , which is most encouraging , " the official said .

Fuzzy STSG, binarize: Officials of the Japanese ministry of education , culture , sports , science and technology , said , " we are very encouraged by the speeches of Abraham .


START
START
IP*
NP
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PU
NP*
NP
NP
VV
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IP
.
NP
NP
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NN
表示
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PU
IP*
IP*
NR
NN
NN
NN
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PP
NP
PU
NP
VP*
VP
日本
文部
科学
省
DNP
NP
,
VV
NP
VV
IP
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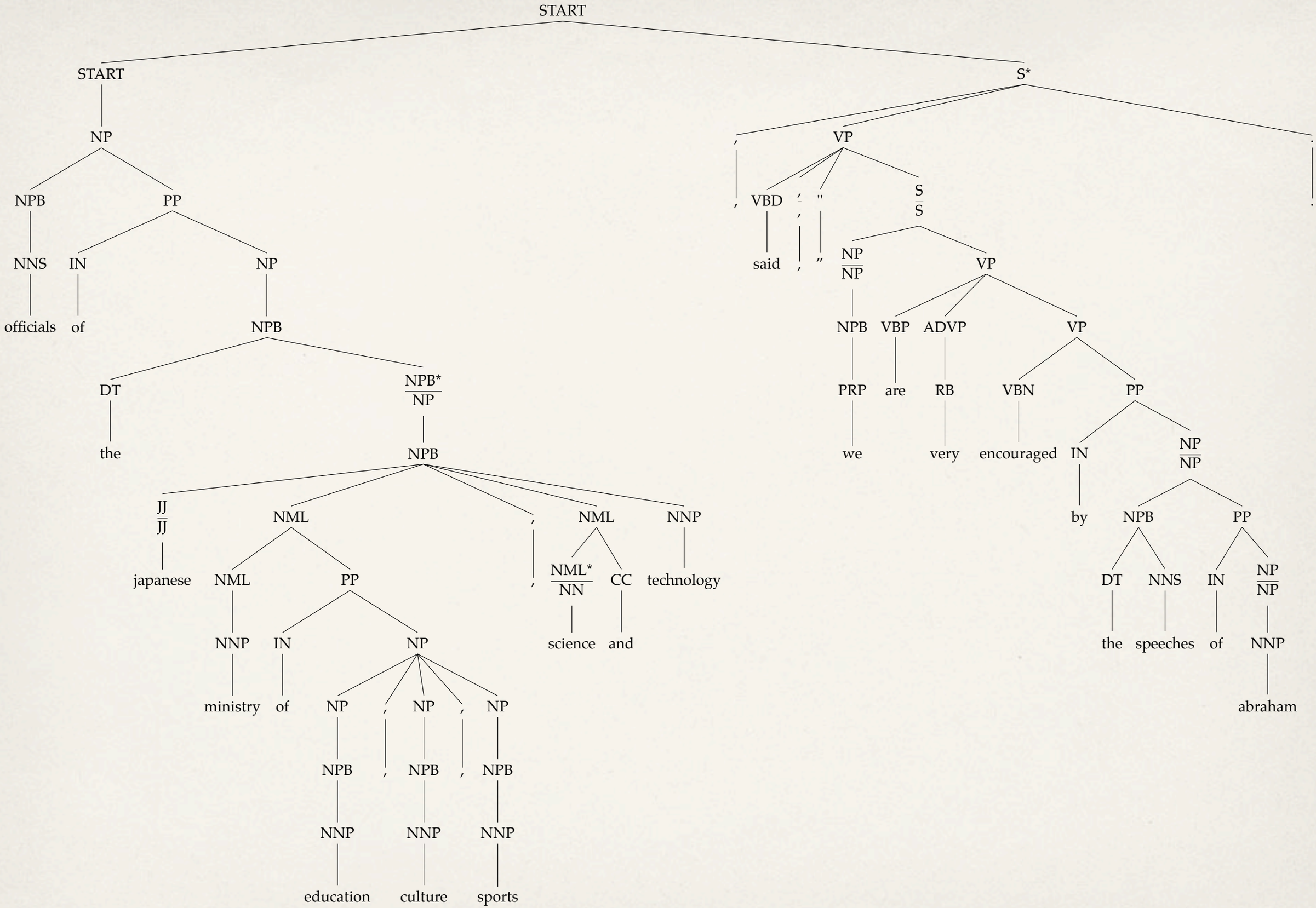
NR
DEG
NN
令
PN
深感
VP
亚伯拉罕
的
发言
我们
VV
鼓舞


START
START
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VP
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NPB
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VBD
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NNS
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,
"
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VP
officials
of
NPB
NPB
VBP
ADVP
VP
DT
NPB*
NP
PRP
are
RB
VBN
PP
the
NPB
we
very
encouraged
IN
NP
NP
JJ
JJ
NML
,
NML
NNP
by
NPB
PP
japanese
NML
PP
,
NML*
NN
CC
technology
DT
NNS
IN
NP
NP
NNP
IN
NP
science
and
the
speeches
of
NNP
ministry
of
NP
,
NP
,
NP
abraham
NPB
,
NPB
,
NPB
NNP
NNP
NNP
education
culture
sports

officials of NPB

DT NPB*/NP

the NPB

JJ/JJ NML , NML NNP

japanese NML PP , NML*/NN CC technology

NNP IN NP science and

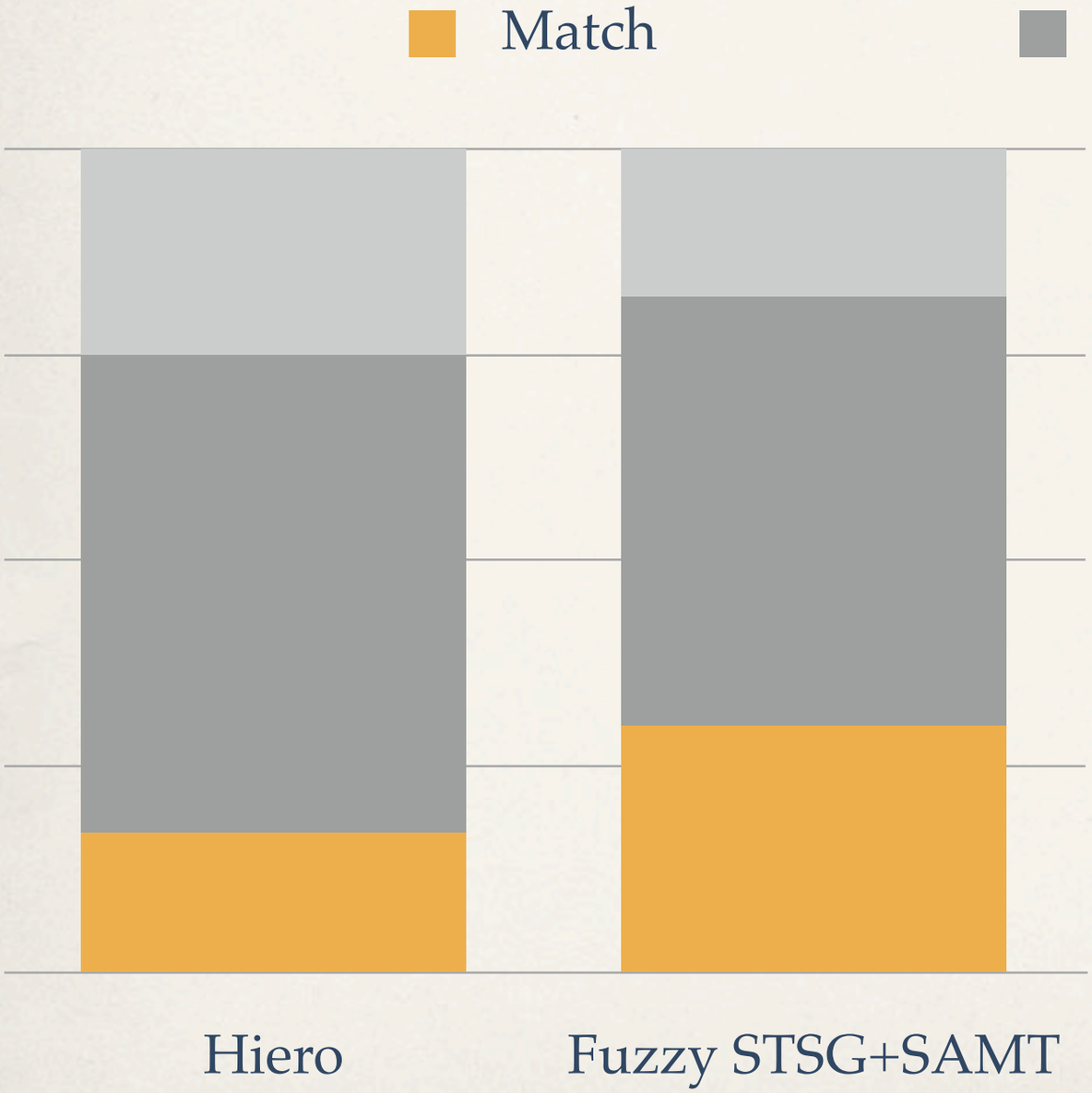
ministry of NP , NP , NP

NPB , NPB , NPB

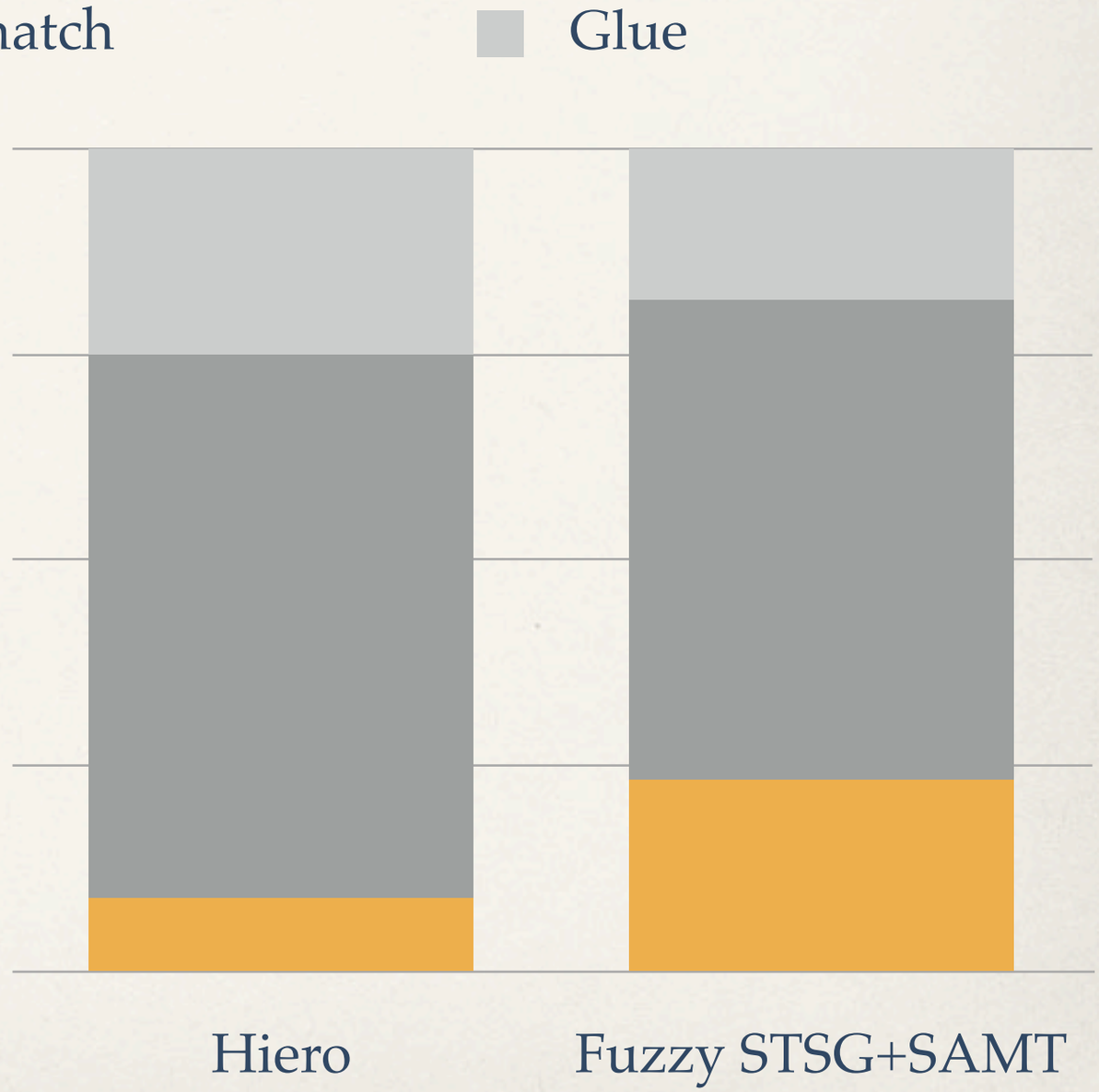
NNP NNP NNP

education culture sports

Rule usage (Chinese-English)

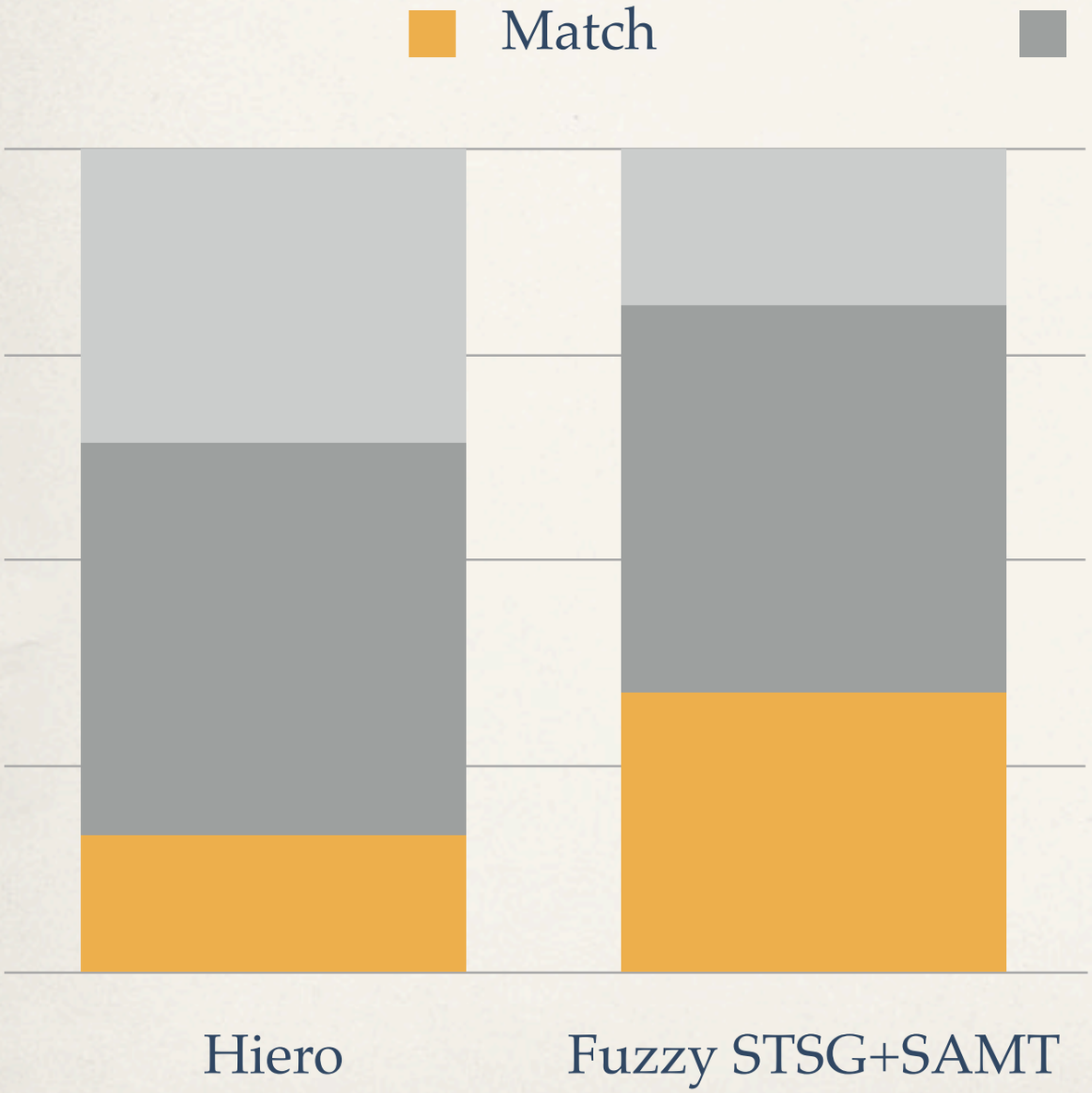


Chinese side

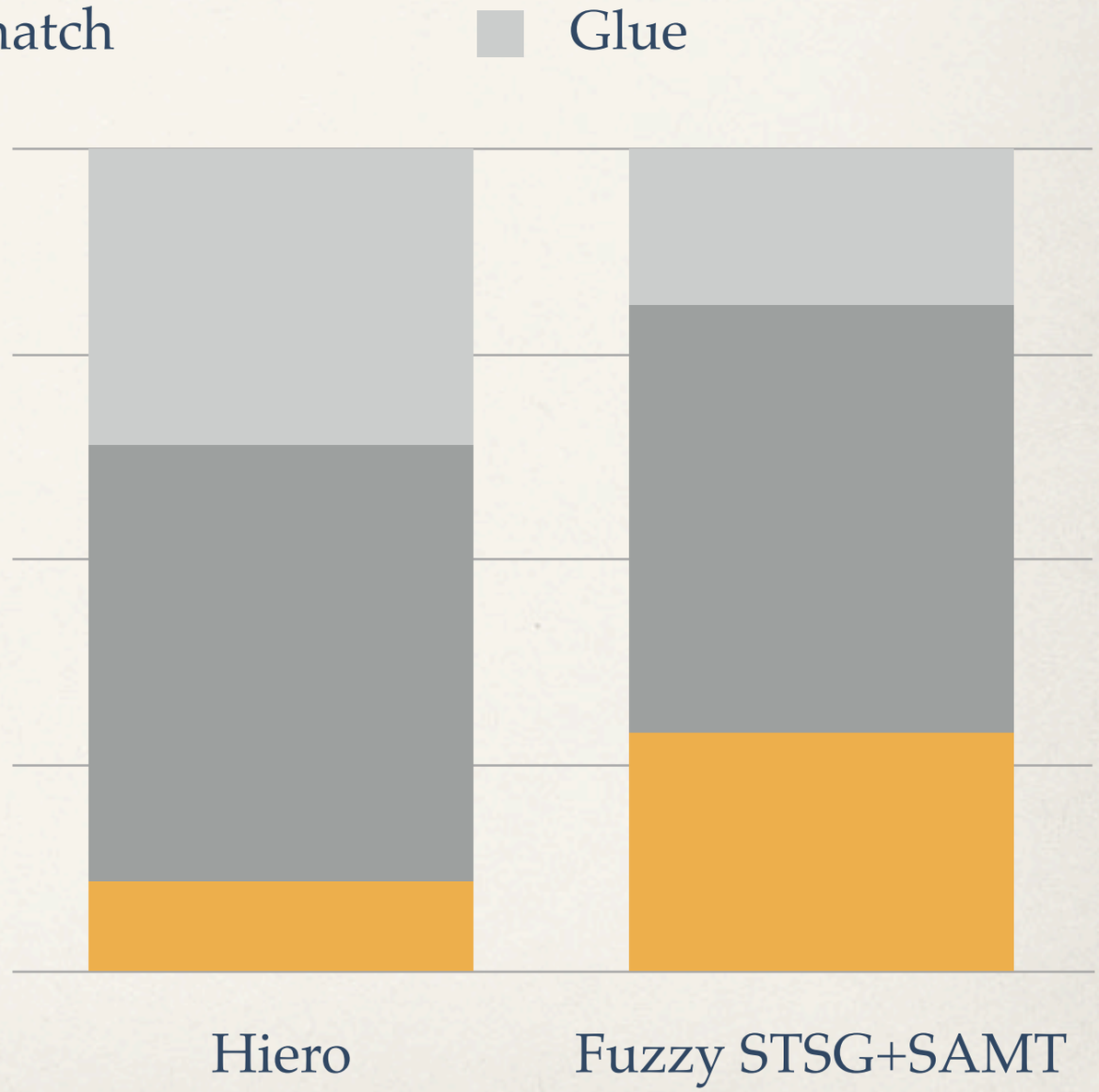


English side

Rule usage (Arabic-English)



Arabic side



English side

Conclusions

- Why is tree-to-tree translation hard?
  - Too few rules
  - Too few derivations
- How can we make it better?
  - Extract more rules: even simple binarization works
  - Allow more derivations: let model learn how much syntax to use