Analyzing the Potential of Source Sentence Reordering in Statistical Machine Translation

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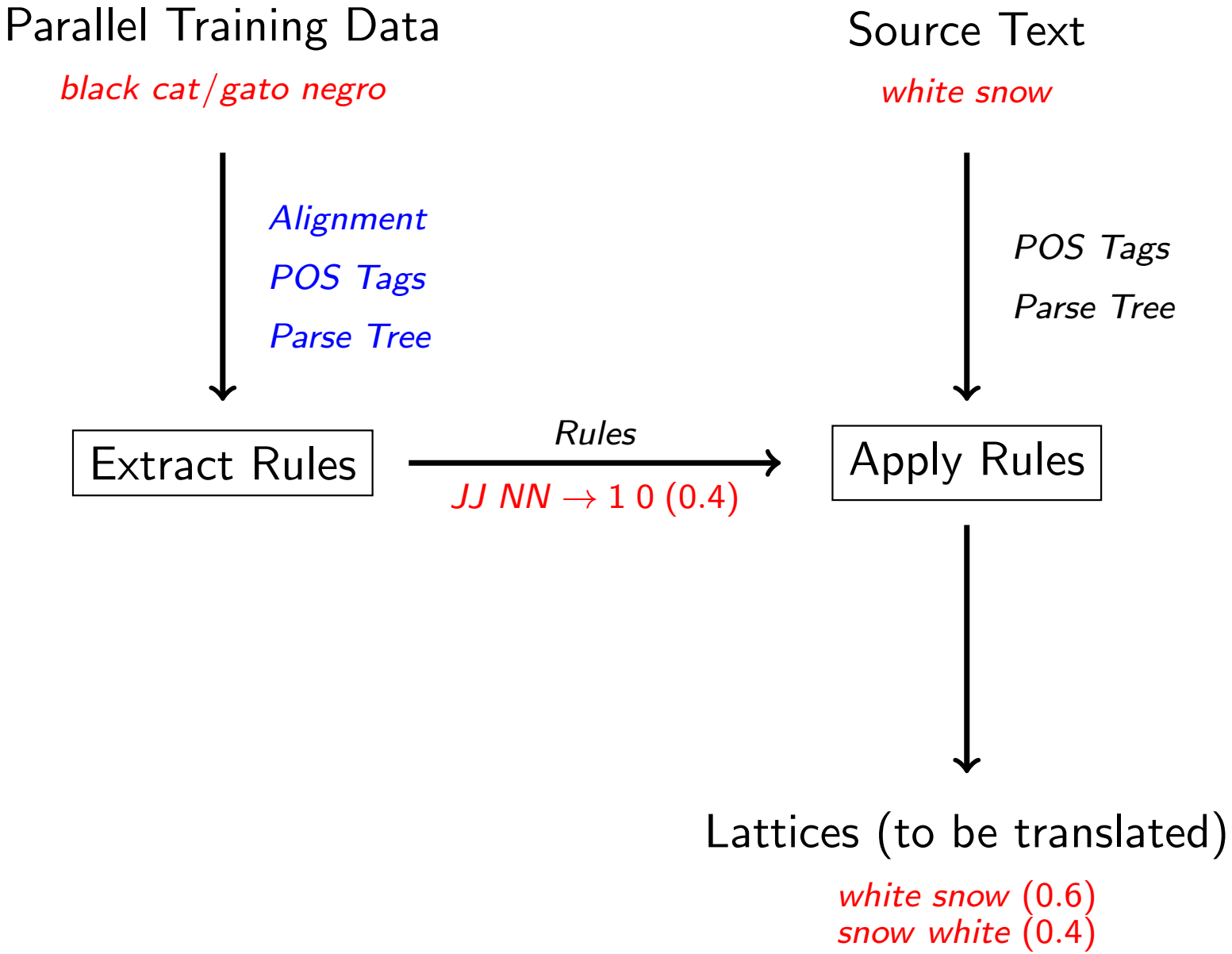
Illustration

English	The black cat climbed to the tree top.
Spanish	The cat black climbed to the top tree.
Japanese	The black cat the tree top to climbed.

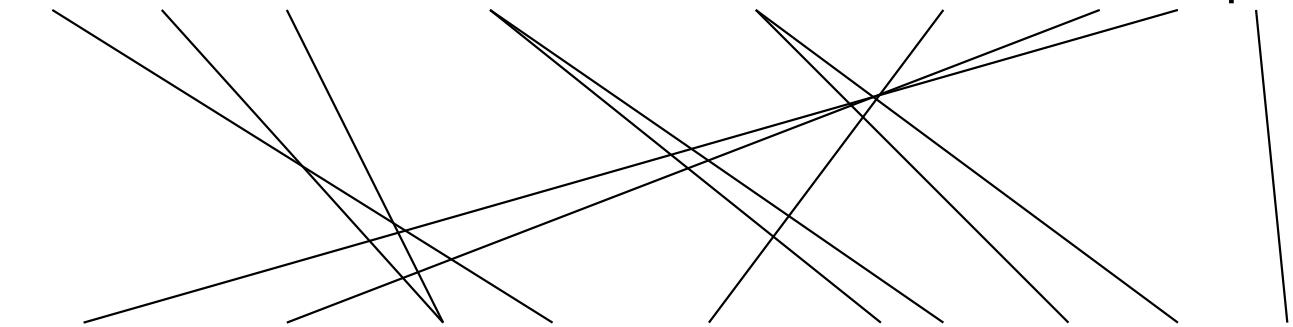
Illustration



Alignment

1 2 3 4 5 6 7 8 9 10 11 12

On the 24th , a series of attacks occurred in Iraq .



伊拉克 境内 二十四 号 发生 了 多 起 袭击 事件 。

1 2 3 4 5 6 7 8 9 10 11

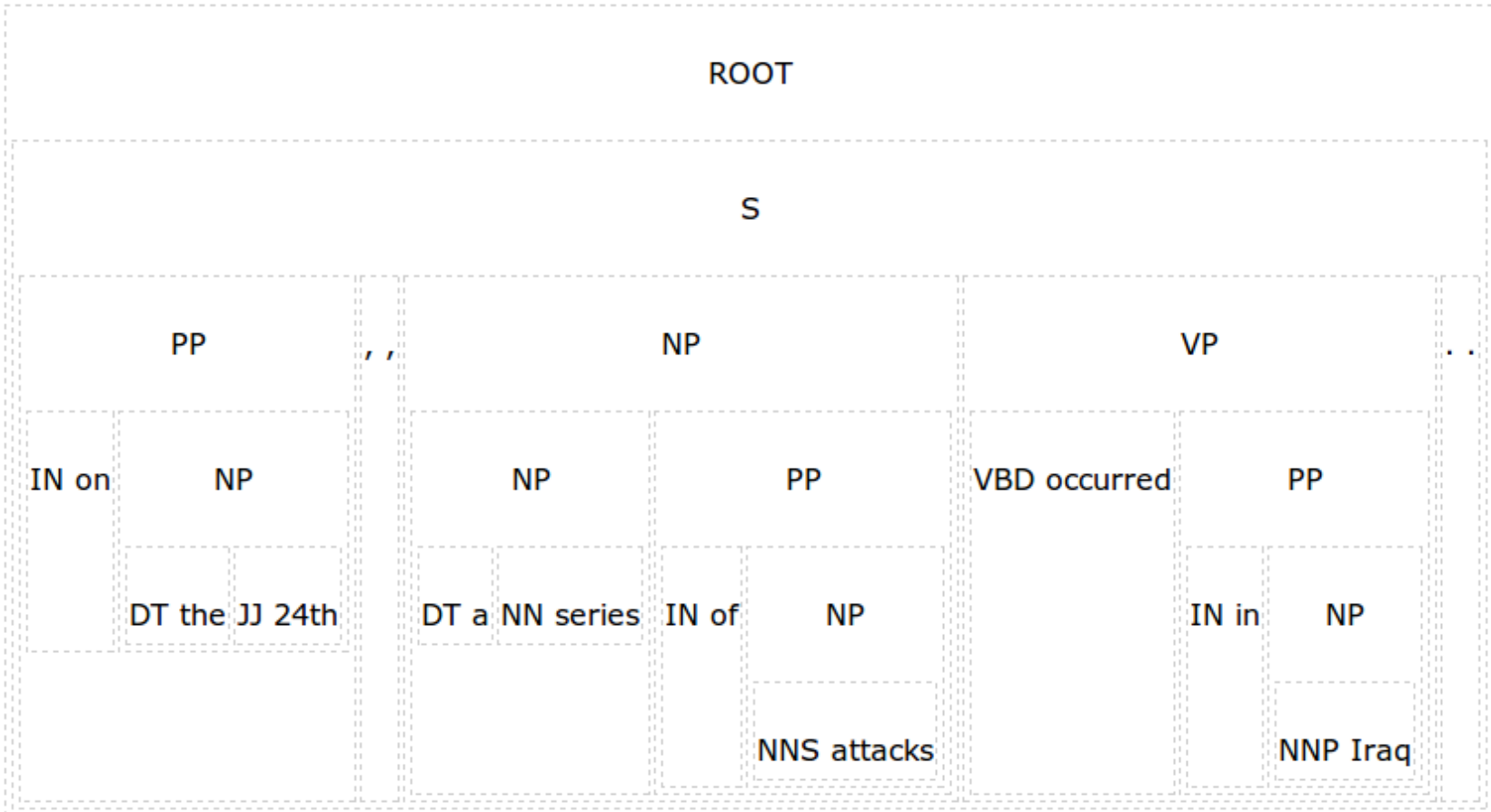
1-4 2-3 3-3 6-7 6-8 8-9 8-10 9-5 10-2 11-1 12-11

POS Tags

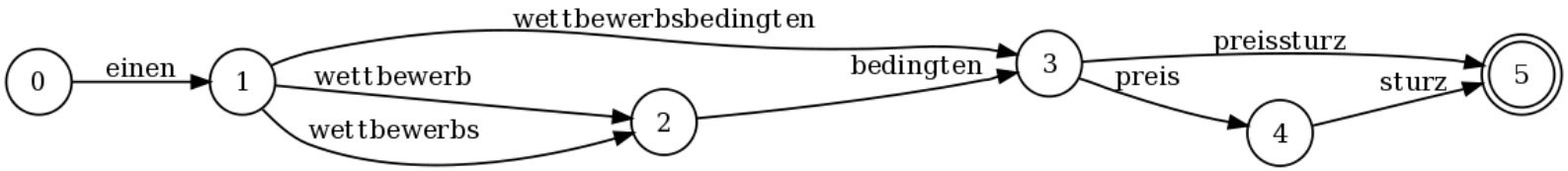
On the 24th , a series of attacks occurred in Iraq .

```
IN DT  JJ , DT NN IN  NNS    VVN IN NP SENT
```

Parse Tree


ROOT
S
PP
, ,
NP
VP
. .
IN on
NP
NP
PP
VBD occurred
PP
DT the
JJ 24th
DT a
NN series
IN of
NP
IN in
NP
NNS attacks
NNP Iraq

Lattices


0
einen
1
wettbewerb
wettbewerbs
2
wettbewerbsbedingten
bedingten
3
preis
preissturz
sturz
4
5

Rule Types

- Short Rules

  JJ NN $\rightarrow$ 1 0 — 0.573
- Long Rules

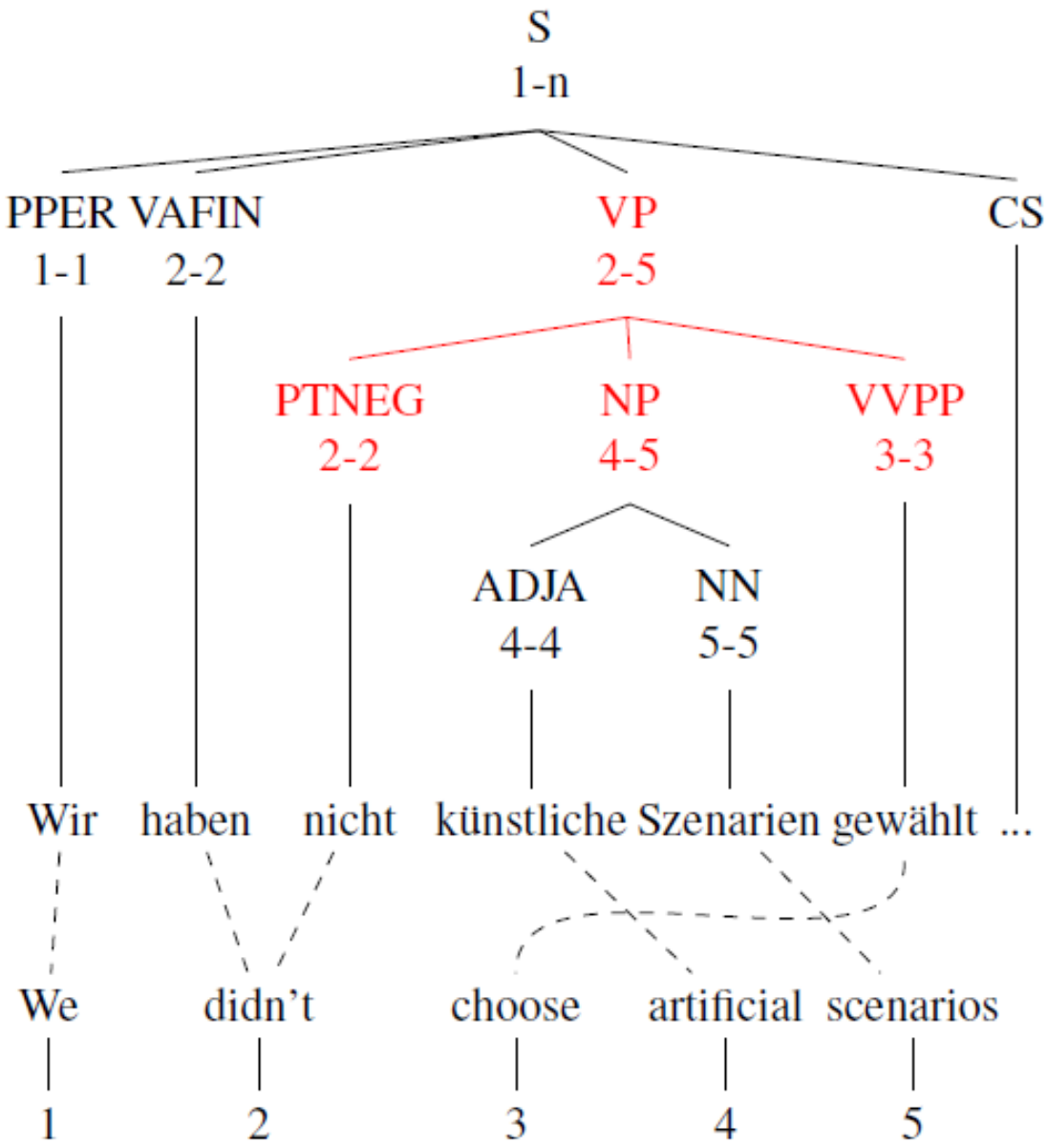
  NN ADV * VAFIN $\rightarrow$ 0 3 1 2 — 0.18
- Tree Rules

  NP (ADJP NNS) $\rightarrow$ 1 0 — 0.103279
- Multilayer Tree Rules

  ADJP (JJ PP (IN NP)) $\rightarrow$ 0 2 1 — 0.02988506

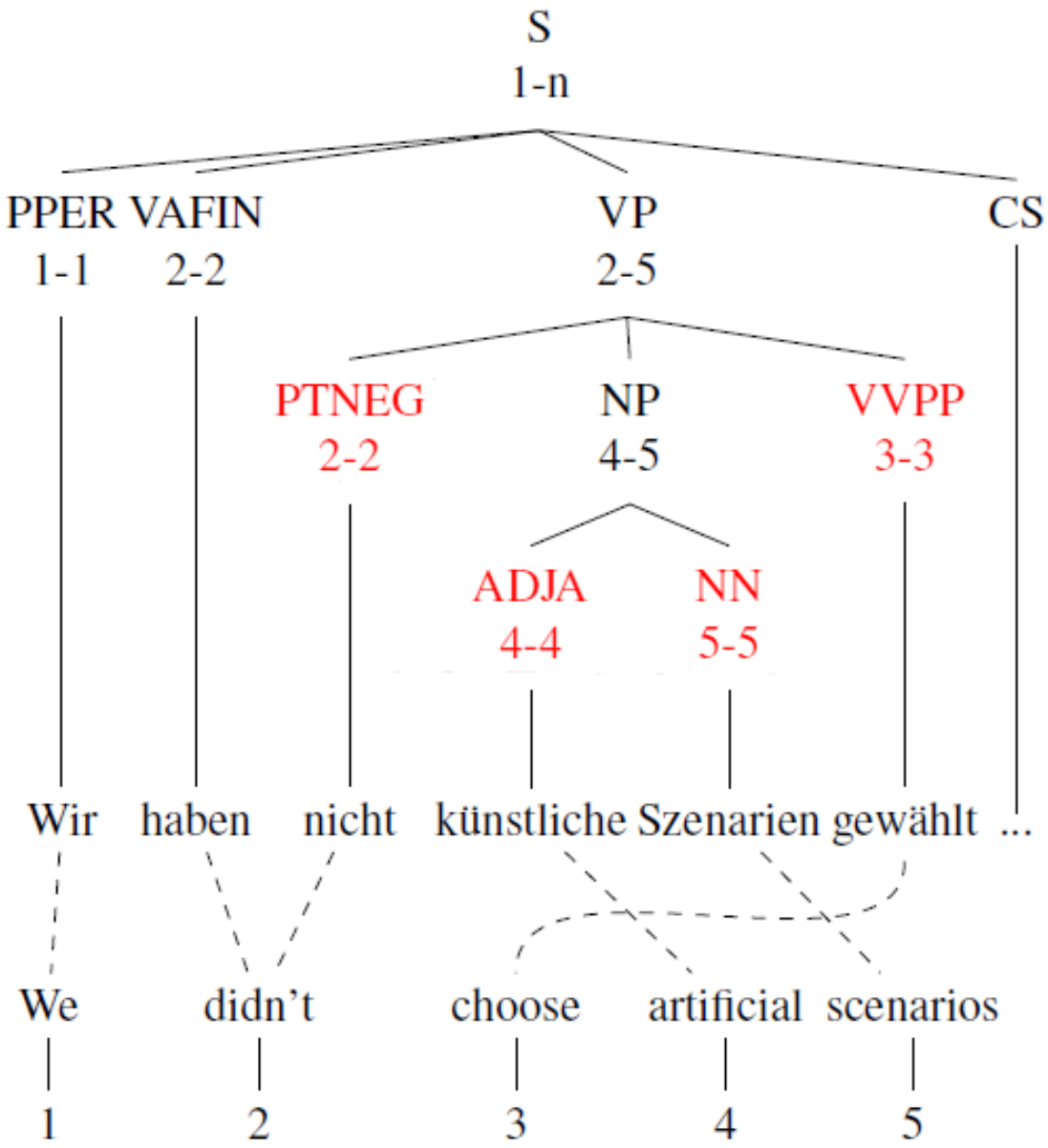
Extracting Rules

VP (PTNEG NP VVPP) → 0 2 1



Extracting Rules

VP (PTNEG NP (ADJA NN) VVPP) → 0 3 1 2



Evaluation

System	Rule #	BLEU Score
Baseline		8.09
Short Rules	95584	8.52
Long Rules	12306	8.57
Tree Rules	1573	8.79
Combined	109456	8.93
Multilayer Tree Rules (layers = 2)	4029	9.04

Training Data: English $\rightarrow$ Chinese, 75873 lines, 12.4MB

Vector Representation as Feature

Corpus

↓ word2vec (Neural Network)

```
...
spain     -0.274035 -0.153813 -0.073527 -0.080498 ...
larger    -0.000062  0.030795 -0.152307 -0.286478 ...
products -0.348087 -0.112983  0.120410 -0.176838 ...
parties   -0.259261 -0.040402 -0.047077 -0.312133 ...
night      0.096195  0.019403  0.063992  0.248290 ...
...
```

Vector Representation as Feature

```
Enter word or sentence (EXIT to break): translation

                  Word              Cosine distance
------------------------------------------------------------
          translations                    0.652776
                 bible                    0.620422
            translated                    0.591767
                  text                    0.564570
            septuagint                    0.559373
            dictionary                    0.557046
               tyndale                    0.546539
               vulgate                    0.542804
            translator                    0.542666
             apocrypha                    0.537319
           translators                    0.526699
                   ...                    ...
```