Integration of a Multilingual Preordering Component into a Commercial SMT Platform

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Outline

1. Word Order in SMT
2. Our Approach
3. Experiments and Evaluation
   - SMT
   - NMT
4. Summary and Future Work

Outline

Word Order in SMT

Introduction

Word order in Statistical Machine Translation

- Translation of a SL word needs to be placed in a TL-specific position

⇒ Fluency of the translations

- Problematic for languages with considerably different syntactic structure, e.g.:

EN:	...that	I	read	a	book	yesterday		.
DE:	...dass	ich	gestern	ein	Buch	gelesen$_{part}$	habe$_{finV}$	.

- Particularly, the long-range reorderings lead to **false placement or omission** of TL words
  ⇒ Negative impact on the adequacy and fluency of the generated translations!

Reordering in SMT

- Many different approaches to handle reordering problems within SMT (cf. **[Bisazza & Federico, 2016]**)
- One of the simplest, yet most effective approaches: **preordering**

EN: ...that I a book yesterday read .

DE: ...dass ich gestern ein Buch gelesen$_{part}$ habe$_{finV}$.

- Reordering may be based on either **automatically derived rules** or **hand-crafted rules**
- Reordering is carried out on **parsed SL sentences**, on the **POS-tagged** or **non-processed SL corpus**

Outline

Reordering for a commercial SMT platform

- Multilingual preordering component for English→Japanese/German/Chinese SMT
- Rule-based reordering based on hand-crafted rules
  ⇒ **improvement already shown by previous research**
  ⇒ **easily adapt to the client's needs**
- Stand-alone component used as a part of corpus preprocessing
  ⇒ **ensures backward compatibility**
- Generic implementation independent of the used parsing software
  ⇒ **allows for usage of different parsers**

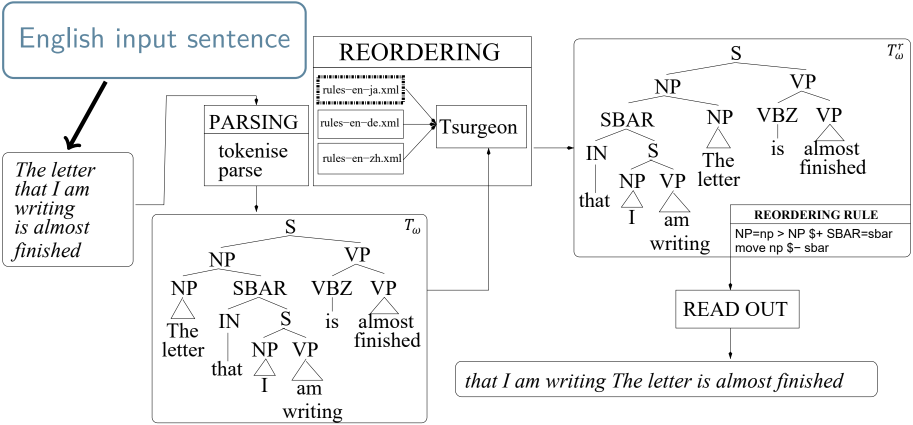
Our Approach

Languages under consideration

1. English→German:
   - Rule set based on [Gojun & Fraser, 2012]
   - Movements of the verbs and negation to capture different positions of the verbs between EN and DE
   - Total of 9 reordering rules
2. English→Japanese:
   - Rule set based on [Lee et al., 2012]
   - Movements of various sentence constituents
   - Total of 7 reordering rules
     and 1 insertion rule (to cope with null subjects in JA)
3. English→Chinese:
   - Rule set developed based on [Wang et al., 2007] and [Wu, 2016]
   - Movements of various sentence constituents
     ⇒ doesn't work!
   - Exclusive reordering of NP-PPs and ofPPs
     (2 rules apply independently)

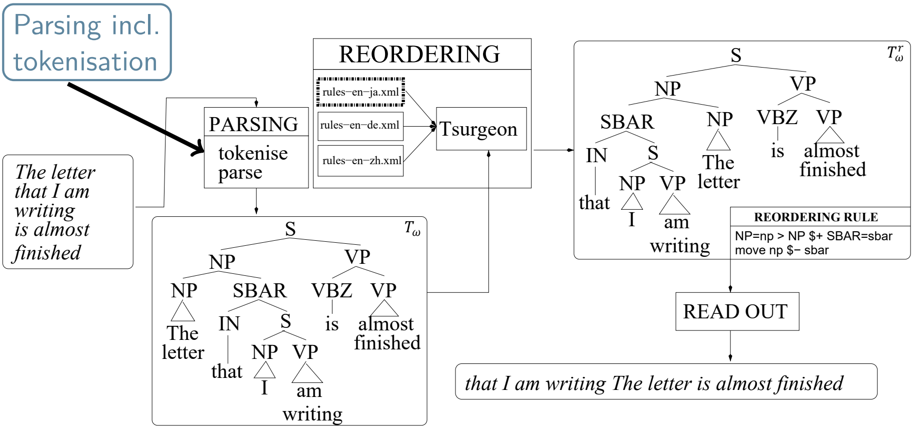
Our Approach

Architecture overview



Our Approach

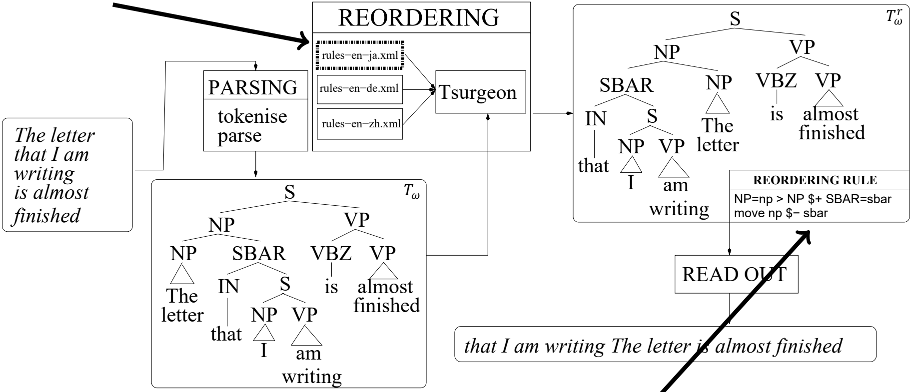
Architecture overview



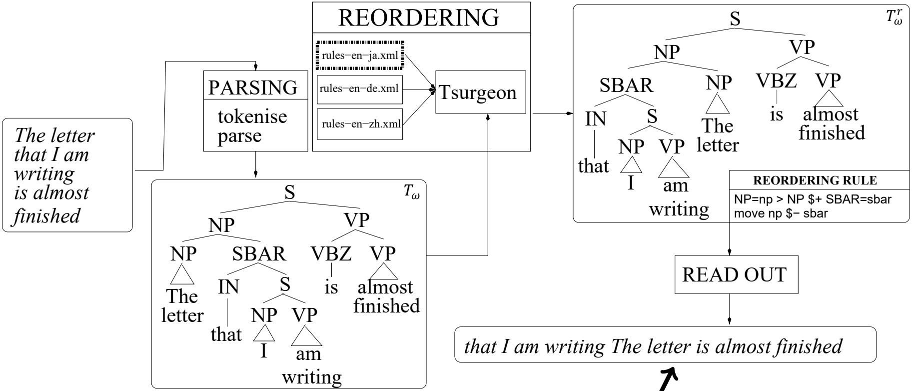
Our Approach

Architecture overview

Reordering based on Tsurgeon



and hand-crafted tree modification rules



Read out the reordered sentence

Our Approach

Architecture overview

Processing steps

- For each sentence in the input file:
  1. Tokenise/parse the input sentence
     (constraints: 5<len(sentence)<60, no special characters)
  2. Modify the parse tree (i.e., perform reordering)
  3. Read out the sentence from the modified parse tree
- After processing the entire input file,
  continue with tokenisation, lowercasing, etc.

Reordering

- **Tsurgeon-based modifications** of the parse trees
  [Levy & Andrew, 2006]
- Rules are defined following **standardised Tsurgeon syntax**
- Rule sets can easily be changed/adapted/extended
- Reordering is invoked only if the reordering rules are given

Implementation details

- Parser runs as a web server
  ⇒ **makes the preordering process independent of the used parser**
- Tsurgeon is modified to enable sentence-wise processing and to avoid infinite loops during tree modifications
  ⇒ **ensures that no SL sentences are lost during preordering**
- Processing parallelised with `GNU parallel` [Tange, 2011]
  ⇒ **leads to a substantially lower reordering time**
  (e.g., reordering of 5,000 segments with the Stanford Shift-Reduce (SR) parser run on 8 cores → the serial implementation took 263.24s, whereas the parallel implementation took 46.10s (5.7 times faster!))

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Training data (legal domain)

	train	tune	test
EN→DE	1,018,738	500	500
EN→JA	213,592	500	500
EN→ZH	387,275	500	500

SMT models

- Trained with Moses
- Tuned on 500 in-domain sentences using MERT
- Distortion limit = 6
- 5-gram LMs trained with the TL of the parallel corpus
- Word alignment: fast_align

Processing time vs. Translation improvement

- Preordering tested using output of **different parsers** with the **same set of reordering rules**

	Baseline		SR			PCFG			BLLIP		
	BLEU	t_t	BLEU	t_r	t_t	BLEU	t_r	t_t	BLEU	t_r	t_t
EN→DE	40.10	187	40.74	97	254	41.17	372	579	41.49	1279	1468
EN→JA	49.44	135	51.33	25	155	50.29	413	544	51.33	372	492
EN→ZH (PP-NP)	24.99	197	24.40	50	245	24.47	252	460	24.66	627	819
EN→ZH (ofPP)			25.09	49	240	25.22	269	464	25.05	633	820

⇒ **BLEU improves for all parsers!**

- Additional processing time when the fastest parser (SR) is used: 36% for EN→DE, 15% for EN→JA, 22-24% for EN-ZH
- **Positive user feedback justifies longer processing time!**

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NMT models

- Trained with OpenNMT
- BPE for EN→DE
- Character-based segmentation for EN→JA/ZH
- Training time: max of 15 epochs

- Automatic (BLEU) & human evaluation (A/B testing) of the NMT outputs:

	Baseline		SR	
	BLEU	Human	BLEU	Human
EN-DE	38.26	49.2	36.74	50.8
EN-JA	67.66	–	60.77	–
EN-ZH (PP-NP)	27.65	36.9	26.67	30.7
EN-ZH (ofPP)			28.75	32.4

⇒ Preordering hurts NMT!

⇒ Confirmed both by automatic, as well as human evaluation

- **Baseline generates the DE verbs in correct positions** (see, e.g., [Bentivogli et al., 2016])
- Preordering seems to have impact both on word order, as well as word choice, e.g.:

EN	The Commission **may**, in any case, **withdraw** such products or substances in accordance with Article37(2).
ENr	The Commission **may**, in any case, such products or substances in accordance with Article37(2) **withdraw**.
B R	Die Kommission **kann** in jedem Fall diese Produkte oder Stoffe gemäß Artikel37 Absatz2 **zurückziehen**. Die Kommission **kann** in jedem Fall solche Erzeugnisse oder Stoffe gemäß Artikel37 Absatz2 **zurückziehen**.
REF	Kommission **kann** in jedem Fall solche Erzeugnisse oder Stoffe gemäß Artikel37 Absatz2 **zurückziehen**.

⇒ Further investigation of preordering for NMT is needed

Summary and Future Work

We presented...

- a fast and customisable preordering component[1]
  for EN$\rightarrow$DE/JA/ZH
- positive impact of preordering on translation quality for SMT
- negative impact of preordering on translation quality for NMT

[1] A simplified version of the preordering component is freely available for research purposes: https://github.com/KantanLabs/KantanPreorder.

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Future work for SMT

- Parallelisation with BLLIP parser
- Use of domain-specific parsers to ensure sufficient parsing quality

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Future work for SMT

- Parallelisation with BLLIP parser
- Use of domain-specific parsers to ensure sufficient parsing quality

Future work for NMT

- Further investigation of the impact of the preordering on NMT
- Multi-source approach to combine reordered and non-reordered SL inputs

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Thank you!

Questions?

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