Exploiting Parallel Treebanks in Phrase-Based Statistical Machine Translation

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Overview

Experimental Setup

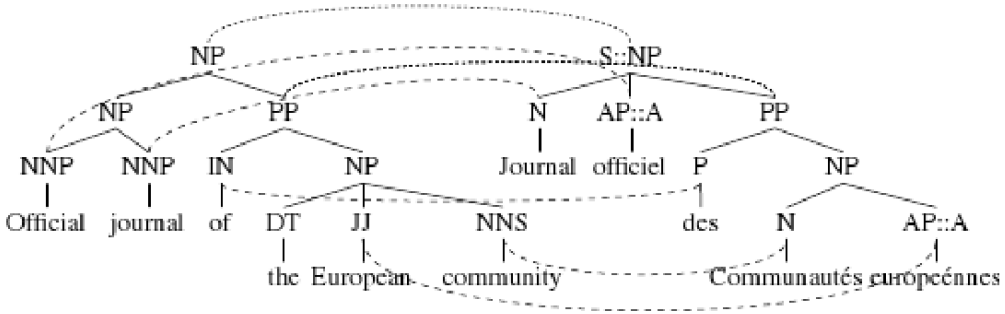
Experiments

Conclusions and Future Work

Overview

- Phrase-based SMT systems contain purely statistically induced translation models
- We have demonstrated on small scale that translation accuracy can be improved by supplementing these models with linguistically motivated phrase pairs extracted from parallel treebanks
- Here we test this hypothesis on a large-scale MT task
- We investigate further ways to exploit parallel treebanks in this MT framework

Aligned Parallel Treebank



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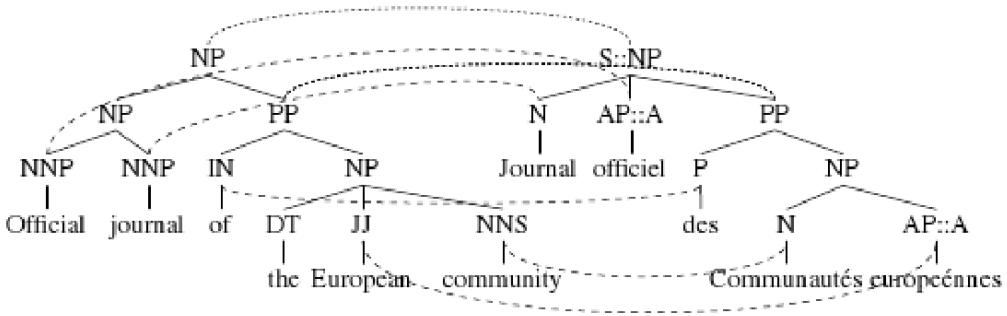
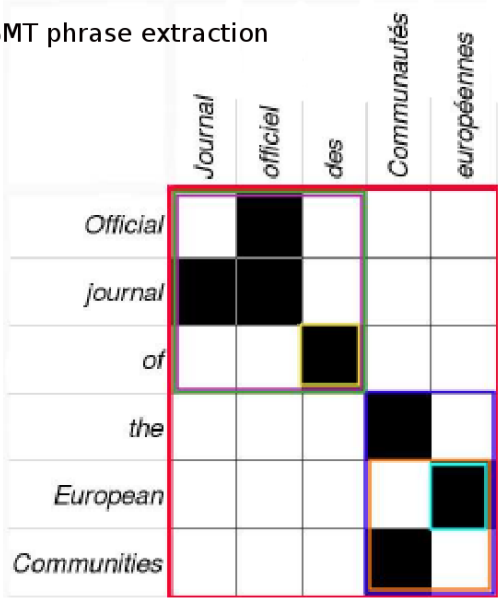


SMT phrase extraction



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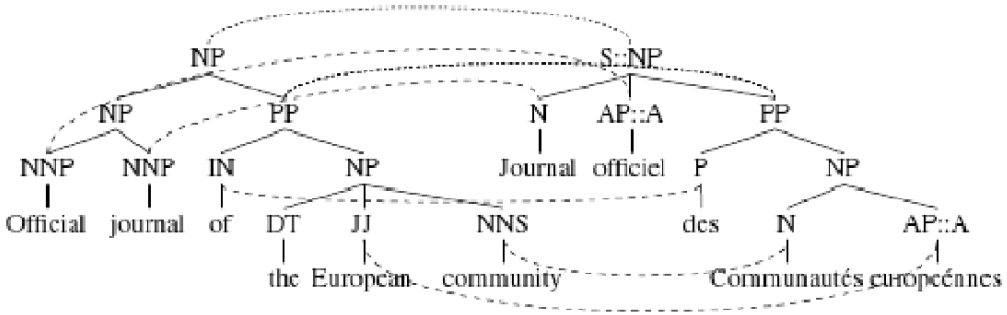

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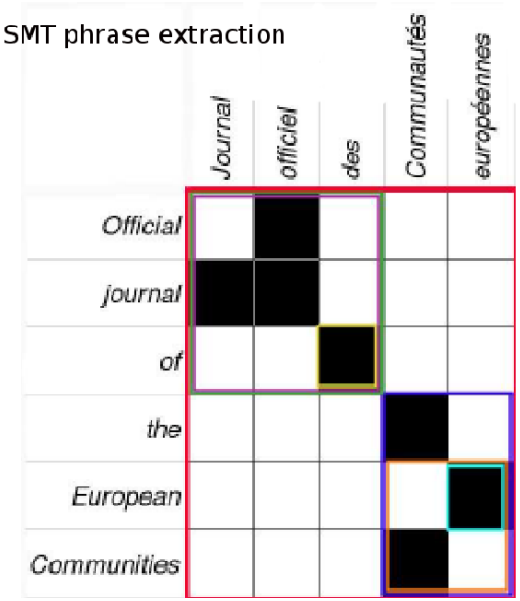

† Official journal ↔ Journal officiel
† Official journal of ↔ Journal officiel des
∗ Official journal of the European Communities ↔ Journal officiel des Communautés européennes
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◇ Communities ↔ Communautés
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◇ journal ↔ Journal

Phrases extracted from the SMT system only
Phrases extracted from the parallel treebank only
Phrases extracted from both the SMT system and the parallel treebank

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MT System

- Baseline PB-SMT system built with Moses
- 5-gram language model (SRILM)
- Minimum error-rate training on devset
- Automatic evaluation using Bleu, Nist and Meteor

Experiment I - Direct Combination

We build three translation models

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Config.	**Bleu**	NIST	%METEOR
Baseline	0.3341	7.0765	57.39
+Tree	**0.3397**	**7.0891**	**57.82**
Tree only	0.3153	6.8187	55.98

Experiment I - Direct Combination

Resource	**Baseline**	**Treebank**
Unique Types	23,261,022	4,985,266
Overlap	1,447,505	
1-to-1	1.54%	15.91%
1-to-n	3.51%	4.43%

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We noticed issues with some treebank word alignments

- Constitute 20.3% of total extracted pairs
- 7.35% were high-frequency alignments between function words and punctuation
- Filtered these from model and rerun translation with this model (Strict phrases)

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Baseline	0.3341	7.0765	57.39
+Tree	0.3397	7.0891	57.82
Strict phrases	**0.3414**	**7.1283**	**57.98**

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Baseline	0.3341	7.0765	57.39
+Tree	**0.3397**	**7.0891**	57.82
Treebank_extr	0.3102	6.6990	55.64
+Tree	0.3199	6.8517	5639
Union_extr	0.3277	6.9587	56.79
+Tree	0.3384	7.0508	**57.88**

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An interesting observation

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Word Alignment	**#Phrases**	**#Phrases+Tree**
Baseline	24.7M	29.7M
Treebank	88.5M	92.89M
Union	7.5M	13.1M

Further Experiments

1. Giving additional weight to treebank phrase pairs in the model
2. Filtering longer phrase pairs from the model
3. Using treebank word alignments to calculate lexical weighting feature in translation model

Conclusions

- improving SMT by supplementing models with treebank phrase pairs scales
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Future Work

- play with different ways to combine the two phrase resources
- investigate extraction of refined phrase tables further
- apply treebanks to more syntactically-aware MT paradigms e.g. Stat-XFER

Thank you

http://computing.dcu.ie/∼jtinsley

http://nclt.dcu.ie/mt

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Experiment III - Weighting Treebank Data

We build three new translation models in which we directly combine the two sets of phrases but we count the treebank phrase pairs 2, 3 and 5 times respectively

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Config.	BLEU	NIST	%METEOR
Baseline+Tree	**0.3397**	**7.0891**	**57.82**
+Tree x2	0.3386	7.0813	57.76
+Tree x3	0.3361	7.0584	57.56
+Tree x5	0.3377	7.0829	57.71

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We use a feature of the MT system which allows us to supply the two phrase tables separately. In this case the decoder will select phrases from either table for translation as is deemed appropriate by the model.

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Config.	BLEU	NIST	%METEOR
Baseline+Tree	**0.3397**	**7.0891**	**57.82**
Two Tables	0.3365	7.0812	57.50

Exploiting Word Alignments

Given a parallel treebank, we also have a set of word alignments between the sentence pairs i.e. alignments between pre-terminal nodes. Word alignments are vital to core tasks in SMT.

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We use treebank based word alignments in place of statistical word alignments in MT for

- phrase translation model extraction
- lexical weight scoring

Experiment IV - Treebank-Based Lexical Weights

- Lexical weights are calculated bidirectionally for each phrase pair based on the word alignment between the source and target phrases.
- Done using the lexical translation probability distribution produced by Giza++

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Config.	BLEU	NIST	%METEOR
Baseline+Tree	**0.3397**	**7.0891**	**57.82**
Treebank_weights	0.3356	7.0355	57.32
Union_weights	0.3355	7.0272	57.41