Multimodal Comparable Corpora for Machine Translation

Haithem Afli, Loïc Barrault and Holger Schwenk
Laboratoire Informatique de l'Université du Maine (LIUM)
University of Le Mans, France
firstname.lastname@lium.univ-lemans.fr

Abstract

The construction of a statistical machine translation (SMT) system requires parallel corpus for training the translation model and monolingual data to build the target language model. A parallel corpus, also called bitext, consists in bilingual/multilingual texts. Unfortunately, parallel texts are a sparse resource for many language pairs. One way to overcome this lack of data is to exploit comparable corpora which are much more easily available. In this paper, we present the corpus developed for automatic parallel data extraction from multimodal comparable corpora, from *Euronews* and *TED* web sites. We describe the content of each corpus and how we extracted the parallel data with our new extraction system. We present the methods considered for using multimodal corpora and discuss the results on bitext extraction.

Keywords: Multimodal Comparable Corpora, Machine Translation, Parallel Data Extraction.

1. Introduction

In recent decades statistical approaches have significantly advanced the development of machine translation (MT). However, the applicability of these methods directly depends on the availability of very large quantities of parallel data. Recent works have demonstrated that a comparable corpus can compensate for the shortage of parallel corpora. However, for some languages, text comparable corpora may not cover all topics in some specific domains. One of the main challenges of our research is to build data and techniques to these under-resourced domains. What we need is to explore other sources like audio to generate parallel texts for each domain.

These kind of data are widely available on the Web for many languages.

In this paper, we present an extraction method used on multimodal comparable corpus. This corpus is then used to adapt and improve machine translation systems that suffer from resource deficiency. We, also, present Euronews-LIUM corpus which has been created within the context of our work on French DEPART[1] project. One of its main objective is the exploitation of multimodal and multilingual data for machine translation.

The methods for improving translation quality proposed in this work rely upon multimodal comparable corpora, that is, multiple corpora in different modalities that cover the same general topics and events. We compare it with (Afli et al., 2013) method built for the same kind of data.

Our main experimental framework is designed to address two situations. The first one is when we translate data from a new domain, different from the training data. In such a condition, the translation quality is generally rather poor. The second one is when we seek to improve the quality of an SMT system already trained on the same kind of data (same domain and/or style). Data is extracted from the available news (video and text modalities) on the *Euronews* website[2]. We also used TED-LIUM (Rousseau et al., 2012) corpus to build our TED multimodal comparable corpus and test our extraction methods.

This paper is organized as follows: the first two sections present the new corpora. Section 3. contains the general extraction system architecture and some results are presented in Section 4.

2. Multimodal comparable corpora

2.1. Euronews

Figure 1: Example of multimodal comparable corpora from the *Euronews* website.

Figure 1 shows an example of multimodal comparable data coming from the *Euronews* website. An audio source of a political news and its text version , both in English, are available along with the equivalent news in French (audio and text modalities). The audio content in the videos are not exactly the same for each language, but are dealing with the same subject. Then, audio in one language and the text content in the other language can be considered as comparable data. This corpus can be used to extract parallel data, at the sentence and the sub-sentential level.

[1] http://www.projet-depart.org/
[2] http://www.euronews.com

Euronews website clusters news into several categories or sub-domains (*e.g.* Sport, Politics, etc.). These categories are preserved in the raw version of the provided corpus (but not in extracted versions). Table 1 show the statistics of our English/French *Euronews-LIUM* corpus created from French [3] and English news data from 2010-2012 period.
This corpus[4] is composed of a comparable corpus, made of transcriptions (performed with our ASR system, see Section 3.2.) and article content (text found on the webpage). The extracted data performed with the system described in Section 3. are also provided.

2.2. TED

TED-LIUM corpus has been created within the context of the IWSLT'11 evaluation campaign. It has been built from some video talks crawled on the TED (Technology, Entertainment, Design) website[5]. The corpus is made of 773 talks representing 118 hours of speech. We used the English audio part of this corpus and the French text part of the *WIT3* parallel corpus[6], to create the TED multimodal comparable corpus, further called TED-LIUM. Figure 2

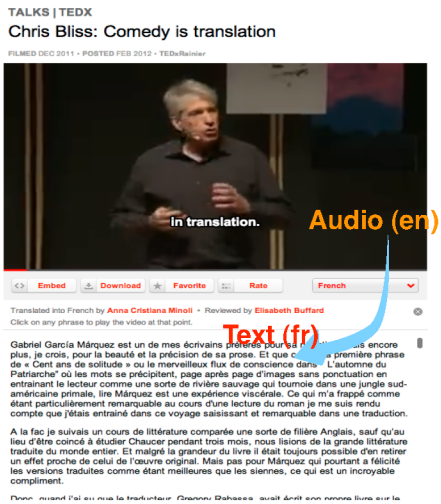


Figure 2: Example of multimodal comparable data from the TED website.

shows an example of such multimodal comparable data.

3. Parallel data extraction

3.1. System Architecture

The basic system architecture is described in Figure 3. We begin by extracting comparable sentences with the same method of (Afli et al., 2012) called *SentExtract*. We can distinguish three steps in this system: automatic speech recognition (ASR), statistical machine translation (SMT) and information retrieval (IR). The ASR system accepts audio data in language L1 as input and generates an automatic transcription. This transcription is then translated by a baseline SMT system into language L2. Then, we use these translations as queries for an IR system

[3] http://fr.euronews.com/
[4] available soon on our website
[5] http://www.ted.com
[6] https://wit3.fbk.eu/

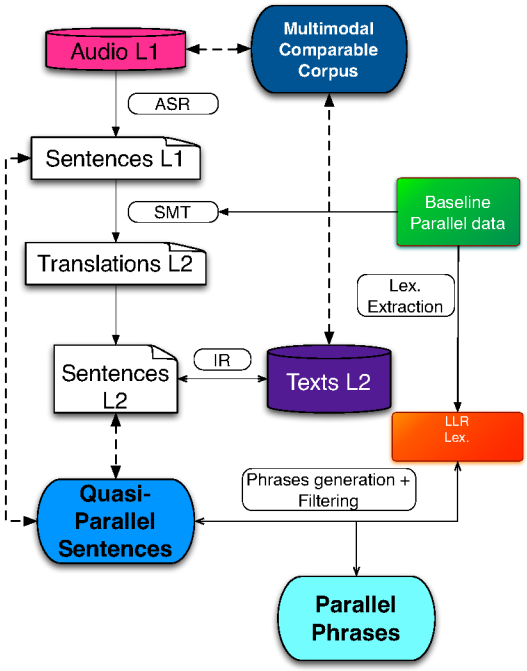
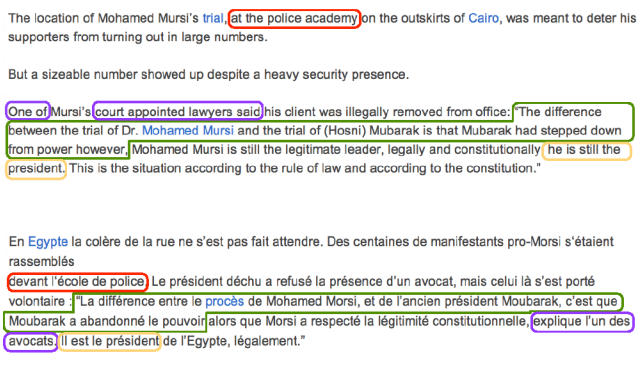


Figure 3: Principle of the parallel data extraction system from multimodal comparable corpora.

to retrieve most similar sentences in the indexed text part of our multimodal comparable corpus. The transcribed text in language L1 and the IR result in language L2 form the comparable sentences.

However, the extracted sentences are of different level of quality, and a filtering step is required in order not to degrade the performance of the baseline system. Previous work make use of different kinds of techniques to filter the extracted sentences, like TER (Snover et al., 2006) between IR query and the returned sentence (Abdul-Rauf and Schwenk, 2011) or bilingual lexicon log-likelihood ratio (Munteanu and Marcu, 2006). One of the drawbacks of filtering is that it can remove a large number of sentences, which often results in a lower impact on the baseline system. Moreover, the withdrawn sentences often


The location of Mohamed Mursi's trial, at the police academy on the outskirts of Cairo, was meant to deter his supporters from turning out in large numbers.

But a sizeable number showed up despite a heavy security presence.

One of Mursi's court appointed lawyers said his client was illegally removed from office: "The difference between the trial of Dr. Mohamed Mursi and the trial of (Hosni) Mubarak is that Mubarak had stepped down from power however, Mohamed Mursi is still the legitimate leader, legally and constitutionally he is still the president. This is the situation according to the rule of law and according to the constitution."

En Egypte la colère de la rue ne s'est pas fait attendre. Des centaines de manifestants pro-Morsi s'étaient rassemblés devant l'école de police. Le président déchu a refusé la présence d'un avocat, mais celui là s'est porté volontaire : "La différence entre le procès de Mohamed Morsi, et de l'ancien président Moubarak, c'est que Moubarak a abandonné le pouvoir alors que Morsi a respecté la légitimité constitutionnelle, explique l'un des avocats. Il est le président de l'Egypte, légalement."

Figure 4: Example of comparable sentences which contain parallels phrases from *Euronews* website.

contain some useful parallel fragments which is interesting to extract.

	Audio En		Text	
Sub-Domain	# words	# sentences	# words Fr	# words En
Business	289909	7898	425001	613684
Sport	81768	2369	112736	102923
Culture	388548	16773	262745	274323
Europe	398675	12531	302665	287178
Life Style	28813	1111	18379	19480
Politics	806607	26002	4932055	4666655
Science	231034	9346	147195	141652
Total	2225354	76030	6213995	6127565

Table 1: Size of the transcribed English audio corpus and English-French texts.

As an example, consider Figure 4, which presents two paragraphs extracted from the news articles presented in Figure 1. Although the articles report on the same event and express overlapping content, the texts cannot be considered as strictly parallel. They contain no fully parallel sentences pairs, but as shown by the boxes in the figure, some parallel phrases do exist in the sub-sentential level.

We developed a parallel phrase extraction system which operates in two steps. First, parallel phrase pair candidates are detected using the IBM1 model (Brown et al., 1993). Then the candidates are filtered with probabilistic translation lexicon (learned on the baseline SMT system training data) to produce parallel phrases using log-likelihood ratio (LLR) method (see (Munteanu and Marcu, 2006) for details). Our technique is similar to that of (Afli et al., 2013) called *PhrExtract*, but we bypass the need of the TER filtering by using a LLR lexicon. We call this new extended system *PhrExtract_LLR*.

3.2. Baseline systems

The ASR system used in our experiments is an in-house five-pass system based on the open-source CMU Sphinx system (version 3 and 4), similar to the LIUM'08 French ASR system described in (Deléglise et al., 2009). The acoustic models were trained in the same manner, except that we added a multi-layer perceptron (MLP) using the Bottle-Neck feature extraction as described in (Grézl and Fousek, 2008).

To train the language models (LM), we used the SRILM toolkit (Stolcke, 2002). We trained a 4-gram LM on all our monolingual corpus.
The SMT system is a phrase-based system based on the Moses SMT toolkit (Koehn et al., 2007). The standard fourteen feature functions are used, namely phrase and lexical translation probabilities in both directions, seven features for the lexicalized distortion model, a word and a phrase penalty and a target language model. It is constructed as follows. First, word alignments in both directions are calculated with the multi-threaded version of the GIZA++ tool (Gao and Vogel, 2008). Phrases and lexical reorderings are extracted using the default settings of the Moses toolkit. The parameters of our system were tuned on a development corpus using the MERT tool (Och, 2003). To train, optimize and test our baseline MT system, we used the data presented in Table 2.

Corpus	# words En	# words Fr
nc7	3.1M	3.7M
eparl7	51.2M	56.4M
devEuronews	74k	84k
tstEuronews	61k	70k
devTED	36k	38k
tstTED	8.7k	9.1k

Table 2: MT training and development data.

For each comparable corpus (Euronews-LIUMand TED-LIUM, we chose the most appropriate development and test corpus. *devEuronews* and *tstEuronews* are the news corpora used in the, respectively, WMT'10 and WMT'11 evaluation campaigns. *devTED* and *tstTED* are the official dev and test corpora from the IWSLT'11 international evaluation campaign.

We use the Lemur IR toolkit (Ogilvie and Callan, 2001) for the sentence extraction procedure with default settings. We first index all the French text considering each sentence as a document. This allows to use the translated sentences as queries to the IR toolkit. The IR system make use of the bag of word representation of each sentence and returns the most similar to the query. This sentence is then paired with the English query sentence.By these means we can retrieve the best matching sentences from the French side of the comparable corpus.

4. Results

For the sake of comparison, we ran several experiments with two methods. The first one, is *PhrExtract_LLR* (presented in section 3., and the second one corresponds to the method applied by (Afli et al., 2013) (called *PhrExtract* as in their paper). Experiments were conducted on English to French TED and Euronews tasks.
PhrExtract uses TER for filtering the result returned by IR, keeping only the phrases which have a TER score below a certain threshold determined empirically. Thus, we filter the selected sentences in each condition with different TER thresholds ranging from 0 to 100 by steps of 10.

The various SMT systems are evaluated using the BLEU score (Papineni et al., 2002).

Methods	# words (en)	# words (fr)
PhrExtract (TER 60)	16.61M	13.82M
PhrExtract_LLR	1.68M	2.27M

Table 3: Number of words and sentences extracted from TED-LIUMcorpus with *PhrExtract* and *PhrExtract_LLR* methods.

Methods	# words (en)	# words (fr)
PhrExtract (TER 50)	2.39M	1.95M
PhrExtract_LLR	636.8k	224.1k

Table 4: Number of words and sentences extracted from Euronews-LIUMcorpus with *PhrExtract* and *PhrExtract_LLR* methods.

Tables 3 and 4 show the statistics of the bitexts extracted from Euronews-LIUMand TED-LIUM. One can note that the sizes of the two sides of the bilingual text extracted from Euronews-LIUMare very different (English side is almost three times larger than French size). This behaviour is not observed on the TED data, and we do not yet explain this fact which requires a more fine grain analysis of the obtained bitexts. These bitexts are injected into our generic training data in order to adapt the baseline MT system.
Tables 5 and 6 present the BLEU scores obtained with the best bitext extracted from each multimodal corpus with *PhrExtract* and *PhrExtract_LLR* methods. The TER threshold is set to 50 for Euronews-LIUMand 60 for TED-LIUM.

Systems	devTED	tstTED
Baseline	22.93	23.96
PhrExtract (TER 60)	23.70	24.84
PhrExtract_LLR	23.63	24.88

Table 5: BLEU scores on devTED and tstTED after adaptation of a baseline system with bitexts extracted from TED-LIUMcorpus.

Systems	devEuronews	tstEuronews
Baseline	25.19	22.12
PhrExtract (TER 50)	30.04	27.59
PhrExtract_LLR	30.00	27.47

Table 6: BLEU scores on devEuronews and tstEuronews after adaptation of a baseline system with bitexts extracted from Euronews-LIUMcorpus.

In the experiment with TED data, we seek to adapt our baseline SMT system to a new domain. We can see in table 5 that our new system obtains similar results as the *PhrExtract* method. This means that the extracted texts are useful for adaptation purpose.
The same behavior is observed on Euronews task (Table 6). The extracted text can be used to improve an existing SMT system already trained on the same kind of data.
This new extraction method bypass the use of the TER filtering which required many experiments in order to determine the best threshold for each task.
Moreover, looking at the extracted text sizes in Tables 3 and 4, we can observe that the LLR method generate much less data while obtaining equivalent performance. This suggests that only the most relevant data is extracted by this technique.
We can see in the example in Table 7, that adding the extracted phrases can have a positive effect on translation quality.

5. Related Work

There has been considerable amount of work on exploiting comparable corpora, although from a different perspective than the one taken in this paper.
(Zhao and Vogel, 2002) proposed an adaptive approach aims at mining parallel sentences from a bilingual comparable news collection collected from the web. A maximum likelihood criterion was used by combining sentence length models and lexicon-based models. The translation lexicon was iteratively updated using the mined parallel data to get better vocabulary coverage and translation probability estimation. In (Yang and Li, 2003), an alignment method at different levels (title, word and character) based on dynamic programming (DP) is presented. The goal is to identify the one-to-one title pairs in an English/Chinese corpus collected from the web, They applied longest common subsequence (LCS) to find the most reliable Chinese translation of an English word. (Resnik and Smith, 2003) propose a web-mining based system called STRAND and show that their approach is able to find large numbers of similar document pairs.
A cross-language information retrieval techniques is used by (Utiyama and Isahara, 2003) to extract sentences from an English/Japanese comparable corpus. They identify similar article pairs, and then, considering them as parallel texts, they align their sentences using a sentence pair similarity score and use DP to find the least-cost alignment over the document pair.
(Munteanu and Marcu, 2005) uses a bilingual lexicon to translate some of the words of the source sentence. These translations are then used to query the database to find matching translations using information retrieval (IR) techniques. (Abdul-Rauf and Schwenk, 2011) bypass the need of the bilingual dictionary by using their own SMT system. They also use simple measures like word error rate (WER) or translation edit rate (TER) in place of a maximum entropy classifier.
In (Munteanu and Marcu, 2006) a first attempt to extract parallel sub-sentential fragments (phrases) from comparable corpora is presented. They used a method based on a Log-Likelihood-Ratio lexicon and a smoothing filter. They showed the effectiveness of their method to improve an SMT system from a collection of a comparable sentences.

Source EN (ASR output)	for me it's a necessity to greece stays in the euro zone and that greece gets the chance to get back on track the problem
Baseline FR	**pour moi une nécessité pour la grèce** reste dans la zone euro et que la **grèce** aura la chance **de revenir sur la piste problème**
Adapted FR	**Je vois la nécessité que la Grèce** reste dans la zone euro et que la **Grèce** aura la chance **de se remettre sur pieds .**

Table 7: Example of translation quality improvements of the baseline MT system after adding parallel data extracted from Euronews-LIUMcorpus.

The second type of approach consist in extracting parallel phrases with an alignment-based approach (Quirk et al., 2007; Riesa and Marcu, 2012). These methods are promising, because (Cettolo et al., 2010) show that mining for parallel fragments is more effective than mining for parallel sentences, and that comparable in-domain texts can be more valuable than parallel out-of-domain texts. But the proposed method in (Quirk et al., 2007) do not significantly improve MT performance and model in (Riesa and Marcu, 2012) is designed for parallel data.
So, it's hard to say that this approach is actually effective for comparable data.
Since our method can increase the precision of the extraction method, it greatly expands the range of corpora which can be usefully exploited.

6. Conclusion

In this paper, we have presented a new multimodal corpus built to extract parallel data for SMT systems. We also presented a new system to extract parallel fragments from a multimodal comparable corpus. Experiments conducted on TED and Euronews data showed that our method significantly outperforms the existing approaches and improves MT performance both in situations of domain adaptation (TED data) and of in-domain improvement (Euronews). This is an encouraging result which do not require any threshold empirically determined comparing to TER filtering method. Our approach can be improved in several aspects. A parallel corpus is used to generate the LLR lexicon used for filtering. An alternative method could be to construct a large bilingual dictionary from comparable corpora, and use it in the filtering module. In this case, the lexicon would benefit from containing words specific to the targeted task (in the case of adaptation). Another interesting extension is to carefully select the comparable data to be used in the extraction framework. This selection could be based on a similarity measure computed before the extraction process, and would help to improve the system performances.

7. Acknowledgements

This work has been partially funded by the French Government under the project DEPART.

8. References

S. Abdul-Rauf and H. Schwenk. 2011. Parallel sentence generation from comparable corpora for improved smt. *Machine Translation*.

H. Afli, L. Barrault, and H. Schwenk. 2012. Parallel texts extraction from multimodal comparable corpora. In *JapTAL*, volume 7614 of *Lecture Notes in Computer Science*, pages 40–51. Springer.

Haithem Afli, Loïc Barrault, and Holger Schwenk. 2013. Multimodal comparable corpora as resources for extracting parallel data: Parallel phrases extraction. *International Joint Conference on Natural Language Processing*, October.

Peter F. Brown, Vincent J. Della Pietra, Stephen A. Della Pietra, and Robert L. Mercer. 1993. The mathematics of statistical machine translation: parameter estimation. *Comput. Linguist.*, 19:263–311, June.

Mauro Cettolo, Marcello Federico, and Nicola Bertoldi. 2010. Mining parallel fragments from comparable texts. *Proceedings of the 7th International Workshop on Spoken Language Translation*.

P. Deléglise, Y. Estève, S. Meignier, and T. Merlin. 2009. Improvements to the LIUM french ASR system based on CMU Sphinx: what helps to significantly reduce the word error rate? In *Interspeech 2009*, Brighton (United Kingdom), 6-10 september.

Q. Gao and S. Vogel. 2008. Parallel implementations of word alignment tool. In *Software Engineering, Testing, and Quality Assurance for Natural Language Processing*, SETQA-NLP '08, pages 49–57.

F. Grézl and P. Fousek. 2008. Optimizing bottle-neck features for LVCSR. In *2008 IEEE International Conference on Acoustics, Speech, and Signal Processing*, pages 4729–4732. IEEE Signal Processing Society.

P. Koehn, H. Hoang, A. Birch, C. Callison-Burch, M. Federico, N. Bertoldi, B. Cowan, W. Shen, C. Moran, R. Zens, C. Dyer, O. Bojar, A. Constantin, and E. Herbst. 2007. Moses: open source toolkit for statistical machine translation. In *Proceedings of the 45th Annual Meeting of the ACL on Interactive Poster and Demonstration Sessions*, ACL '07, pages 177–180.

D. S. Munteanu and D. Marcu. 2005. Improving Machine Translation Performance by Exploiting Non-Parallel Corpora. *Computational Linguistics*, 31(4):477–504.

D. S. Munteanu and D. Marcu. 2006. Extracting parallel sub-sentential fragments from non-parallel corpora. In *Proceedings of the 21st International Conference on Computational Linguistics and the 44th annual meeting of the Association for Computational Linguistics*, ACL-44, pages 81–88.

Franz J. Och. 2003. Minimum error rate training in statistical machine translation. In *Proceedings of the 41st An-*

nual Meeting on Association for Computational Linguistics - Volume 1, ACL '03, pages 160–167, Stroudsburg, PA, USA. Association for Computational Linguistics.

P. Ogilvie and J. Callan. 2001. Experiments using the lemur toolkit. *Procedding of the Trenth Text Retrieval Conference (TREC-10)*.

K. Papineni, S. Roukos, T. Ward, and W.-J. Zhu. 2002. Bleu: a method for automatic evaluation of machine translation. In *Proceedings of the 40th Annual Meeting on Association for Computational Linguistics*, ACL '02, pages 311–318.

Q. Quirk, R. Udupa, and A. Menezes. 2007. Generative models of noisy translations with applications to parallel fragment extraction. In *In Proceedings of MT Summit XI, European Association for Machine Translation*.

Philip Resnik and Noah A. Smith. 2003. The web as a parallel corpus. *Comput. Linguist.*, 29:349–380, September.

J. Riesa and D. Marcu. 2012. Automatic parallel fragment extraction from noisy data. In *Proceedings of the 2012 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies*, NAACL HLT '12, pages 538–542.

Anthony Rousseau, Paul Deléglise, and Yannick Estève. 2012. Ted-lium: an automatic speech recognition dedicated corpus. *Proceedings of the Eight International Conference on Language Resources and Evaluation (LREC'12)*.

S. Snover, B. Dorr, R. Schwartz, M. Micciulla, and J. Makhoul. 2006. A study of translation edit rate with targeted human annotation. *Proceedings of Association for Machine Translation in the Americas*, pages 223–231.

A. Stolcke. 2002. SRILM - an extensible language modeling toolkit. In *International Conference on Spoken Language Processing*, pages 257–286, November.

M. Utiyama and H. Isahara. 2003. Reliable measures for aligning japanese-english news articles and sentences. In *Proceedings of the 41st Annual Meeting on Association for Computational Linguistics - Volume 1*, ACL '03, pages 72–79.

Christopher C. Yang and Kar Wing Li. 2003. Automatic construction of english/chinese parallel corpora. *J. Am. Soc. Inf. Sci. Technol.*, 54:730–742, June.

B. Zhao and S. Vogel. 2002. Adaptive parallel sentences mining from web bilingual news collection. In *Proceedings of the 2002 IEEE International Conference on Data Mining*, ICDM '02, Washington, DC, USA. IEEE Computer Society.