Construction of English MWE Dictionary and its Application to POS Tagging

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Abstract
This paper reports our ongoing project for constructing an English multiword expression (MWE) dictionary and NLP tools based on the developed dictionary. We extracted functional MWEs from the English part of Wiktionary, annotated the Penn Treebank (PTB) with MWE information, and conducted POS tagging experiments. We report how the MWE annotation is done on PTB and the results of POS and MWE tagging experiments.

1 Introduction
While there have been a great progress in POS tagging and parsing of natural language sentences thanks to the advancement of statistical and corpus-based methods, there still remains difficulty in sentence processing stemming from syntactic discrepancies. One of such discrepancies is caused by multiword expressions (MWEs), which are known and defined as expressions having “idiosyncratic interpretations that cross word boundaries (or spaces)” (Sag et al., 2002).

Sag et al. (2002) classifies MWEs largely into the following categories:

- Lexicalized phrases
  - fixed expressions: Those having fixed word order and form (e.g. by and large).
  - semi-fixed expressions: Those having fixed word order with lexical variation such as inflection, determiner selection, etc. (e.g. come up with).
  - syntactically flexible expressions: Those having a wide range of syntactic variability (e.g. phrasal verbs that take an NP argument between or following the verb and the particle).

- Institutionalized phrases
  - Phrases that are semantically and syntactically compositional, such as collocations (e.g. traffic light).

This paper reports our ongoing project for developing an English MWE dictionary of a broad coverage and MWE-aware natural language processing tools. The main contributions of this paper are as follows:

1. Construction of an English MWE dictionary (mainly consisting of functional expressions) through extraction from Wiktionary.
2. Annotation of MWEs in the Penn Treebank (PTB).
3. Implementation of an MWE-aware POS tagger and evaluation of its performance.

2 Related work
While there is a variety of MWE researches only a few of them focus on MWE lexicon construction. Though some examples, such as French adverb dictionaries (Laporte and Voyatzi, 2008; Laporte et al., 2008), a Dutch MWE dictionary (Grégoire, 2007) and a Japanese MWE dictionary (Shudo et al., 2011) have been constructed, there is no freely available English MWE dictionary with a broad coverage. Moreover, MWE-annotated corpora are only available for a few languages, including French and

1. [https://en.wiktionary.org](https://en.wiktionary.org)
Swedish. While the British National Corpus is annotated with MWEs, its coverage is far from complete. Considering this situation, we started construction of an English MWE dictionary (with functional expressions first) and classified their occurrences in PTB into MWE or literal usage, obtaining MWE-annotated version of PTB.

The effect of MWE dictionaries have been reported for various NLP tasks. Nivre and Nilsson (2004) investigated the effect of recognizing MWEs in syntactic dependency parsing of Swedish. Korkontzelos and Manandhar (2010) showed performance improvement of base phrase chunking by annotating compound and proper nouns. Finlayson and Kulkarni (2011) reported the effect of recognizing MWEs on word sense disambiguation.

Most of the previous approaches to MWE recognition are based on frequency or collocation measures of words in large scale corpora. On the other hand, some previous approaches tried to recognize new MWEs using an MWE lexicon and MWE-annotated corpora. Constant and Sigogne (2011) presented MWE recognition using a Conditional Random Fields (CRFs)-based tagger with the BIO schema. Green et al. (2011) proposed an MWE recognition method using Tree Substitution Grammars. Constant et al. (2012) compared two phrase structure analysis methods, one that uses MWE recognition as preprocessing and the other that uses a reranking method.

Although MWEs show a variety of flexibilities in their appearance, most of the linguistic analyses consider the fixed type of MWEs. For example, the experiments by Nivre and Nilsson (2004) focus on fixed expressions that fall into the following categories:

1. Multiword names
2. Numerical expressions
3. Compound function words
   (a) Adverbs
   (b) Prepositions
   (c) Subordinating conjunctions
   (d) Determiners
   (e) Pronouns

Multiword names and numerical expressions behave as noun phrases and have limited syntactic functionalities. On the other hand, compound function words have a variety of functionalities that may affect language analyses such as POS tagging and parsing. In this work, we extract compound functional expressions from the English part of Wiktionary, and classify their occurrences in PTB into either literal or MWE usages. We then build a POS tagger that takes MWEs into account. In implementing this, we use CRFs that can handle a sequence of tokens as a single item (Kudo et al., 2004). We evaluate the performance of the tagger and compare it with the method that uses the BIO schema for identifying MWE usages (Constant and Sigogne, 2011).

3 MWEs Extraction from Wiktionary

To construct an English MWE dictionary, we extract entries from the English part of Wiktionary (as of July 14, 2012) that include white spaces. We extract only fixed expressions that are categorized either as adverbs, conjunctions, determiners, prepositions, prepositional phrases or pronouns. We exclude compound nouns and phrasal verbs since the former are easily recognized by an existing method such as chunking and the latter need more sophisticated analyzing methods because of their syntactic flexibility. We also exclude multiword adjectives since many of them are semi-fixed and behave differently from lexical adjective, having predicative usage only. Table 1 summarizes the numbers of MWE entries in Wiktionary and the numbers of them that appear at least once in PTB.

4 Annotation of MWEs in PTB

While it is usually not easy to identify the usage of an MWE as either an MWE or a literal usage, we initially thought that the phrase structure tree annotations in PTB would have enough information to identify their usages. This assumption is correct in many cases (Figures 1(a) and 1(b)). The MWE usage of “a bit” in Figure 1(a) is analyzed as “NP–ADV”, suggesting it is used as an adverb, and the literal usage of “a bit” in Figure 1(b) is labeled as “NP”, suggesting it is used literally. However, there are a number of examples that are annotated differently while their usages are the same. For example, Figures 1(c), 1(d) and 1(e) all show RB us-
Table 1: Number of MWE types in Wiktionary and Penn Treebank

|          | Adverb | Conjunction | Determiner | Preposition | Prepositional Phrase | Pronoun |
|----------|--------|-------------|------------|-------------|----------------------|---------|
| Wiktionary | 1501   | 49          | 15         | 110         | 165                  | 83      |
| PTB      | 468    | 35          | 9          | 77          | 66                   | 18      |
| Examples | after all | as well as | a number of | according to | against the law | no one |

Figure 1: Examples of phrase structures annotated to “a bit”

5 Experiments of POS tagging and MWE recognition

5.1 Experiment Setting

We conduct POS tagging experiments on the MWE-annotated PTB, using sections 0-18 for training and sections 22-24 for test as usual.

For the experiments, we use four versions of PTB with the following POS annotations.

(a) Original: PTB with the original POS annotation
(b) Revised: PTB with correction of inconsistent POS tags
(c) BIO MWE: MWEs are annotated with the BIO schema
(d) MWE: MWEs are annotated as single words

Concerning the MWE annotation in (c) and (d), the total number of MWE tokens in PTB is 12131 (9417 in the training chapters, 1396 in the test chapters, and 1319 for the remaining (development) chapters).

Each word is annotated with the following in-
Table 2: Examples of MWE annotations in four versions

| Version | Word/POS          |
|---------|-------------------|
| (a) Original | about RB to/TO   |
| (b) Revised   | about IN to/TO    |
| (c) BIO MWE   | about RB-B to/RI  |
| (d) MWE       | about to/RB       |

Table 3: Feature templates used in CRF training

| Unigram features                        |
|-----------------------------------------|
| Surface form                           |
| FPOS, Surface form                      |
| CPOS, Surface form                      |

| Bigram features (left context / right context) |
|-----------------------------------------------|
| Surface form / FPOS, Surface form            |
| FPOS, Surface form / Surface form            |
| Tail POS, Surface form / Head POS, Surface form |
| Tail POS / Head POS                          |
| Tail POS / Surface form                      |

In the case of (d), since MWEs are analyzed as single words, they are expanded into the internal words with their POS tags and the evaluated on the token basis.

MWE recognition accuracy is evaluated for the cases of (c) and (d). For the purpose of comparison, we employ a simple baseline as well. This baseline assigns each occurrence of an MWE its most frequent usage in the training part of PTB. Evaluation of MWE recognition accuracy is shown in precision, recall and F-measure.

We use the standard set of features based on unigram/bi-gram of words/POS. For our MWE version, we add the word forms and POS tags of the first and the last internal words of MWEs as shown in Table 3.

5.2 Experimental Results

Table 4 shows the results of POS tagging. A slight improvement is observed in (b) compared with (a) because some of inconsistent tags are corrected. Further improvement is achieved in (d). The experiment on (c) does not show improvement even over
correct: · · · who/ WP after all/RB is/VBZ really/RB a/DT bit/JJ player/NN on/in the/DT stage/NN · · ·
system: · · · who/ WP *after/IN *all/DT is/VBZ really/RB *a bit/ RB player/NN on/in the/DT stage/NN · · ·

Figure 3: Example of errors: “after all /RB” and “a /DT bit /JJ.”

Table 4: Per token accuracy (precision)

| Version            | Accuracy |
|--------------------|----------|
| (a) Original       | 97.54    |
| (b) Revised        | 97.56    |
| (c) BIO MWE        | 97.32    |
| (d) split MWE      | 97.62    |

Table 5: Recognition performance of MWEs

|       | Precision | Recall | F-measure |
|-------|-----------|--------|-----------|
| Baseline | 78.79     | 80.26  | 79.51     |
| (c) BIO  | 92.81     | 90.90  | 90.18     |
| (d) MWE  | 95.75     | 97.16  | 96.45     |

Table 6: Recognition error of MWEs

| Error types | # of errors |
|-------------|-------------|
| False Positives | 33          |
| False Negatives  | 19          |
| Misrecognition   | 17          |

One example of Misrecognition errors stems from ambiguous MWEs. For example, while “how much” only has MWE usages as RB, there are two RB usages of “how much” that have different POS tag sequences for the internal words. Other examples of Misrecognition are due to zero or low frequency MWEs, whose substrings also matches shorter MWEs: “quite/ RB, a few/PRP” while correct analysis is “quite a few/ RB”, and “the hell/ RB, out of/ IN” while the correct analysis is “the hell out of/ RB”.

6 Conclusion and Future work

This paper presented our ongoing project for construction of an English MWE dictionary, and its application to MWE-aware POS tagging. The experimental results show that the MWE-aware tagger achieved better performance on POS tagging and MWE recognition. Although our current MWE dictionary only covers fixed types of functional MWEs, this dictionary and MWE annotation information on PTB will be made publicly available.

We plan to handle a wider range of MWEs such as phrasal verbs and other semi-fixed and syntactically flexible MWEs, and to develop a POS tagger and a syntactic parser on top of them.

References

Matthieu Constant and Anthony Sigogne. 2011. MWU-Aware Part-of-Speech Tagging with a CRF Model and Lexical Resources. In Proceedings of the Workshop on Multiword Expressions: from Parsing and Generation to the Real World, MWE ’11, pages 49–56.
Matthieu Constant, Anthony Sigogne, and Patrick Watrin. 2012. Discriminative Strategies to Integrate Multiword Expression Recognition and Parsing. In Proceedings of the 50th Annual Meeting of the Association for Computational Linguistics, ACL ’12, pages 204–212.

Mark Alan Finlayson and Nidhi Kulkarni. 2011. Detecting Multi-Word Expressions improves Word Sense Disambiguation. In Proceedings of the Workshop on Multiword Expressions: from Parsing and Generation to the Real World, MWE ’11, pages 20–24.

Spence Green, Marie-Catherine de Marneffe, John Bauer, and Christopher D Manning. 2011. Multiword Expression Identification with Tree Substitution Grammars: A Parsing tour de force with French. In Proceedings of the Conference on Empirical Methods in Natural Language Processing. EMNLP ’11, pages 725–735.

Nicole Grégoire. 2007. Design and Implementation of a Lexicon of Dutch Multiword Expressions. In Proceedings of the Workshop on a Broader Perspective on Multiword Expressions, MWE ’07, pages 17–24.

Ioannis Korkontzelos and Suresh Manandhar. 2010. Can Recognising Multiword Expressions Improve Shallow Parsing? In Human Language Technologies: The 2010 Annual Conference of the North American Chapter of the Association for Computational Linguistics, HLT ’10, pages 636–644.

Taku Kudo, Kaoru Yamamoto, and Yuji Matsumoto. 2004. Applying conditional random fields to japanese morphological analysis. In Proceedings of the Conference on Empirical Methods in Natural Language Processing, EMNLP ’04, pages 230–237.

Eric Laporte and Stavroula Voyatzi. 2008. An Electronic Dictionary of French Multiword Adverbs. In Language Resources and Evaluation Conference. Workshop Towards a Shared Task for Multiword Expressions, MWE ’08, pages 31–34.

Eric Laporte, Takuya Nakamura, and Stavroula Voyatzi. 2008. A French Corpus Annotated for Multiword Nouns. In Proceedings of the Language Resources and Evaluation Conference. Workshop Towards a Shared Task on Multiword Expressions, MWE ’08, pages 27–30.

Joakim Nivre and Jens Nilsson. 2004. Multiword Units in Syntactic Parsing. In Workshop on Methodologies and Evaluation of Multiword Units in Real-World Applications, MEMURA ’04, pages 39–46.

Ivan A Sag, Timothy Baldwin, Francis Bond, Ann A Copestake, and Dan Flickinger. 2002. Multiword Expressions: A Pain in the Neck for NLP. In Proceedings of the Third International Conference on Computational Linguistics and Intelligent Text Processing, CICLing ’02, pages 1–15.