Word Sense Disambiguation System for Myanmar Word in support of Myanmar-English Machine Translation

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Abstract: Word Sense Disambiguation (WSD) has always been a key problem in Natural Language Processing. WSD is defined as the task of finding the correct sense of a word in a specific context. It is an intermediate task essential to many natural language processing problems, including machine translation, information retrieval and speech processing. There is not any cited work for resolving ambiguity of words in Myanmar language. In this paper, we propose an approach to solve the ambiguity of Myanmar words for Myanmar-English machine translation. Our approach is based on Nearest Neighbor Cosine classifier to disambiguate ambiguous words with part-of-speech 'noun' and 'verb', which uses topical feature that represent co-occurring words in bag-of-word feature. The system uses Myanmar-English parallel corpus as training data. The proposed system can improve the translation accuracy for Myanmar-English machine translation system.

Keywords: Word Sense Disambiguation, machine translation, Myanmar-English parallel corpus

1. INTRODUCTION

Word sense disambiguation (WSD) has been a hot topic in the machine translation domain of natural language processing (NLP). WSD can be defined as the process of identifying the correct sense or meaning of a word in a particular context. In machine translation, translation selection is a process that selects an appropriate target language word corresponding to a word in a source language. The meaning of a word may vary significantly according to the context in which it is used. One of the main challenges is that of lexical choice in the case of semantic ambiguity, i.e., the choice for the most appropriate word in the target language for a word in the source language when the target language offers more than one option for the translation and these options have different meanings, all of them having the same part of speech.

In the early machine translation system, there was no disambiguation function, and people always choose the most common sense regarding polysemous words. That's why the quality of machine translation (MT) was poor [14]. WSD refers to a task that automatically assigns a sense, selected from a set of pre-defined word senses to an instance of a polysemous word in a particular context. WSD is an important but challenging technique in the area of natural language processing (NLP). It is necessary for many real world applications such as machine translation (MT), semantic mapping (SM), semantic annotation (SA) and ontology learning (OL). It is also believed to be helpful in improving the performance of many applications such as information retrieval (IR), information extraction (IE) and speech recognition (SR) [11].

We propose an approach to disambiguate senses of several polysemous Myanmar words for Myanmar-English translation. For example, the polysemous Myanmar noun " ကျွန်း (kjun)" would translate to two different English words (**island** for the land surrounded by water sense or **teak** for the kind of hard wood sense) in the following two sentences:

a. "ကျွန်းပတ်လည်တွင်ရေရှိသည်။"

(There is water around the **island**.) and

b. "ကျွန်ုပ်၏အိမ်ကိုကျွန်းဖြင့်တည်ဆောက်ထားသည်။"

(My house is built of **teak**.)

In order to translate this ambiguous word to correct English word, WSD is needed to perform. In this paper, we present an application of WSD in machine translation (MT), where the system has to select the correct translation equivalent in the target language of a polysemous item in the source language. Our method is based on Nearest Neighbor Cosine classifier. All the processes in our system are developed by Java Programming.

The remainder of this paper is organized as follows: We discuss Ambiguity of Myanmar Language in section 2 and the related work in section 3. Section 4 and 5 show the overview of Statistical Machine Translation System and Word Sense Disambiguation System. Section 6 describes Nearest Neighbor Cosine Classification and section 7 presents Myanmar-English parallel corpus. Section 8 present the overview of the proposed system. Execution of Proposed WSD Algorithm is shown in section 9. Experimental result is described in section 10 and the paper is concluded in section 11.

2. AMBIGUITY OF MYANMAR LANGUAGE

Myanmar language is an official language of the Union of Myanmar. It is written from left to right and no spaces between words, although informal writing often contains spaces after each clause. It is syllabic alphabet and written in circular shape. It has sentence boundary mark. It is a free-word-order language, which usually

follows the subject-object-verb (SOV) order. In particular, preposition adjunctions can appear in several different places of the sentence. Unlike Myanmar, English Language has a rigid subject-verb-object (SVO) order.

However, Myanmar language has semantic ambiguity problem like English. Although using statistical methods has been very successful for some of important problems in Myanmar Natural Language Processing such as Part-Of-Speech tagging, segmentation and alignment of parallel translation, an effective method for solving semantic ambiguity problem does not exist yet. Consequently, this problem is frequently cited as one of the most important problems in natural language processing research today. Table 1 and 2 show some examples of Myanmar ambiguous nouns and verbs and its English meaning.

Table 1 Some Ambiguous nouns and their senses

Ambiguous word	No: of sense	Examples	Meaning
တူ (tu)	3	သူသည်**တူ**ဖြင့်ခေါက်ဆွဲစားသည်။ He eats the noodle with **chopsticks**.	chopsticks
		သူမှာ**တူ**သုံးယောက်ရှိသည်။ He has three **nephews**.	nephews
		လက်သမားသည်**တူ**ကိုသုံးသည်။ Carpenter uses the **hammer**.	hammer
ငွေ (ngwe)	2	လက်ကောက်ကို**ငွေ**ဖြင့်ပြုလုပ်ထား သည်။ Bracelet is made of **silver**.	silver
		ဦးမြတွင်**ငွေ**အများအပြားရှိသည်။ U Mya has a lot of **money**.	money

Table 2 Some Ambiguous Verbs and their senses

Ambiguous word	No: of senses	Examples	Meaning
သောက်သည် (thoukthe)	3	ဦးလှသည်အရက်အလွန်**သောက်သည်**။ U Hla **drinks** too much alcohol.	drink
		သူသည်နေ့စဉ်ဆေးပြားသုံးပြား**သောက် သည်**။ He **takes** three pills daily.	take
ဝင်သည် (winthe)	5	ရထားသည်ဥမင်လိုက်ခေါင်းကို **ဝင်သည်**။ The train **entered** a tunnel.	enter
		ကျွန်မအဖေသည်အသက်ခြောက်ဆယ် ကိုကို**ဝင်သည်**။ My father **reaches** the age of 60.	reach
		သူသည်တပ်ထဲသို့**ဝင်သည်**။ He **joins** the army.	join
		နေသည်အရှေ့ဘက်မှထွက်ပြီး အနောက်ဘက်သို့**ဝင်သည်**။ The sun rises from the east and **sets** to the west.	set
		ဆီပုံးသည်ဂါလံငါး**ဝင်သည်**။ The oil box **holds** five gallons.	hold

3. RELATED WORK

Many researchers have been work for word sense disambiguation in English and other Languages. For the research reported in this paper, we will emphasis on the ambiguity of the Myanmar words because it is still now open in Machine Translation. In the following paragraphs, we discuss briefly some of the related work and history in the area of Word Sense Disambiguation for other languages.

Xiaohua Zhou and Hyoil Han presented Survey of Word Sense Disambiguation Approaches (2005) [11]. Phil Katz proposed supervised word sense disambiguation using Python (2005) [7].He implements five different context based classifiers and also presented a meta-classifier that combines the outputs of the stand-alone systems into one classification. He showed that nearest neighbor cosine classifier is the most precise classifier in his system. Ishizaki (2006) performed a word sense disambiguation system using modified Bayesian algorithms for Indonesian language [6].

Sunee Pongpinigpinyo and Wanchai Rivepiboon presented distributional semantics approach to Thai word sense disambiguation (2006) [9]. In 2008, Samir Elmougy, Taher Hamza and Hatem M.Noaman discussed rooting algorithm with Naïve Bayes Classifier for Arabic Word Sense Disambiguation [8]. Farag Ahmed and Andreas Nurnberger (2008) proposed Arabic/English Word translation disambiguation using parallel corpora and matching schemes [1]. Farag Ahmed and Andreas Nürnberger (2009) showed Corpora based Approach for Arabic/English Word Translation Disambiguation [2]. Yu Zheng-tao, Deng Bin, Hou Bo, Han Lu and Guo Jian-yi (2009) discussed word sense disambiguation based on Bayes model and information gain [12]. Zhang Zheng and Zhu Shu (2009) proposed a new approach to WSD in machine translation [14]. After performing extensive reading on methods for disambiguation senses, we propose an approach based on nearest neighbor cosine classifier to be implemented in our system because it is reportedly as having good results.

4. OVERVIEW OF STATISTICAL MACHINE TRANSLATION SYSTEM

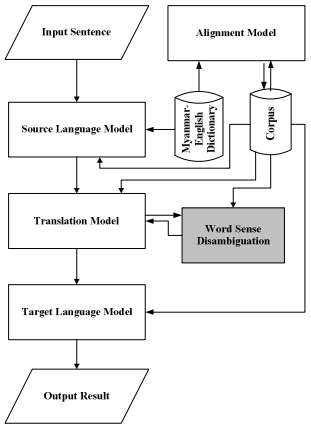

Fig.1 Myanmar-English Statistical Machine Translation System

Fig. 1 describes the process of Myanmar-English statistical machine translation. The Statistical Machine Translation (SMT) is to learn how to translate from a large corpus of pairs of equivalent source and target sentences. To implement a Myanmar-English translation system, there are various problems that need to solve. This includes Source Language Model, Alignment Model, Translation Model and Target Language Model. Our work focuses on Word Sense Disambiguation process used in Translation Model. This phase is the most difficult stage with respect to the level of possible ambiguities. It is even more problematic when it comes to deal with two very divergent languages such as Myanmar and English. As an advantage, the proposed system can improve the accuracy of Myanmar to English language translation. The system is the first attempt to solve ambiguity in Myanmar language. It is also a part of the Myanmar to English Statistical machine translation project.

5. WORD SENSE DISAMBIGUATION

Word Sense Disambiguation (WSD) can be defined as the process of identifying the correct sense or meaning of a word in a particular context. When a human being is encountered with a word with multiple senses, he easily identifies the exact sense of the word with the help of context without giving a single thought to the other senses. But when the same situation is provided to a computer it is not an easy task to correctly identify the desired sense. WSD process helps in resolving such ambiguity issues. Sometimes a word differs in meaning when its Part-Of-Speech (POS) is different. For example butter can be a verb or a noun as it can be seen in the following example:

Will you spread butter [Noun] on toast?

Don't think you can butter [Verb] me up that easily.

In one sentence butter as a noun means “a solid yellow food made from milk or cream”, while in the other sentence butter as a verb means “to say nice things to someone so that they will do what you want”. As such ambiguities can easily be resolved with the help of POS, WSD does not entertain such words. The word with different meanings having same POS needs some WSD process to conclude the accurate sense. For example Chair in English can be “a separate seat for one person” or “the person in charge of a meeting or an organization”.

There are many uses for WSD. The most obvious application of WSD is Machine Translation. The machine translation process requires at least two stages: understanding the source language translation and generating sentences in the target language. WSD is required in both stages since a word in the source language may have more than one possible translation in the target language. In order to be able to correctly translate a text, we need to know which sense is intended in the text.

There are various information sources or feature types used in WSD regardless of the type of the approach. To disambiguate a word, a diversity of information, including syntactic tags, word frequencies, collocations, semantic context, role-related expectations, and syntactic restrictions can be considered. Many WSD algorithms rely on contextual similarity to help choose the proper sense of a word in context. Several important methodological issues come up in the context of word sense disambiguation. These are all words approach or unsupervised and supervised or lexical sample approach. Many Word Sense Disambiguation approaches use dictionaries and thesauri, WordNet, automatic corpus-based and variation or combination of above as sources.

5.1 WSD Approaches

WSD algorithm can be divided into two approach based on the way they acquire information. These approaches are corpus based approaches and knowledge based approaches.

5.1.1. Corpus Based Approaches

In corpus based approaches, information is gained from training on some corpus. A corpus provides a set of samples that enables the systems to develop some numerical models. This approach can further be classified into two subclasses based on the training corpus as follows: supervised disambiguation and unsupervised disambiguation.

5.1.1.1. Supervised Disambiguation

Supervised disambiguation is an application of the supervised learning approach for creating a classifier. A disambiguated corpus where each occurrence of an ambiguous word is annotated with a contextually appropriate sense is available for training. The aim in supervised disambiguation is to build a classifier which correctly classifies new cases based on their context of use. Machine learning algorithms such as Bayesian classifiers, decision lists, decision trees, k-nearest neighbor and neural networks all fall into this category. A major problem with supervised approaches is the need for a large sense-tagged training set. Despite the availability of large corpora, manually sense-tagging of a corpus is very difficult and very few sense-tagged data are available now.

5.1.1.2. Unsupervised Disambiguation

In unsupervised disambiguation, information is gathered from raw corpora which have not been semantically disambiguated. Unsupervised methods correspond to clustering tasks rather than sense tagging tasks. Indeed, completely unsupervised disambiguation is not possible for word senses since sense tagging requires characterization of the senses. WSD can be divided into two sub problems: sense discrimination and sense labeling. If sense labeling is part of the task, an outside source of knowledge is necessary to define the senses. Sense discrimination can be done in a completely unsupervised way. It divides the occurrences of a word into a number of classes by determining for

any two occurrences whether they belong to the same sense or not.

5.1.2. Knowledge based approaches

Knowledge based approaches use Machine Readable Dictionaries (MRD). It relies on information provided by Machine Readable Dictionaries (MRD). In this approaches, all the senses of a word to be disambiguated are retrieved from dictionary. Each of these senses is then compared to the dictionary definitions of all the remaining words in context. The sense with maximum overlap is chosen as the suitable sense.

6. NEAREST NEIGHBOR COSINE CLASSIFICATION

The nearest neighbor cosine classifier is a supervised approach. It uses the context vectors created for each sense during training and for the ambiguous instance during testing. The cosines between the ambiguous vector and each of the context vectors are calculated, and the sense that is the "nearest" (largest cosine/smallest angle) is selected by the classifier. In this method, the distance between two examples is computed by summing the distances between the features values associated with those examples. The similarity between context vectors and for the ambiguous instance is computed through the Cosine distance as below:

$$\cos\ \theta = \frac{A \cdot B}{\| A \| . \| B \|} = \frac{\sum_{i=1}^{n} A_i . B_i}{\sqrt{\sum_{i=1}^{n} A_i^2} \sqrt{\sum_{i=1}^{n} B_i^2}}$$

7. MYANMAR-ENGLISH PARALLEL CORPUS

Parallel Corpora are also called bilingual corpora, one serving as primary language, and the other working as secondary language. A bilingual corpus was used since different senses of some words often translate differently in another language. In our experiments, we use Myanmar-English parallel corpus as training resource. There is no Myanmar-English parallel corpus which contains Myanmar polysemous words in public. So, we create Myanmar-English parallel corpus that contain ambiguous words manually. It contains various sense meanings of ambiguous Myanmar words. We present the following sentences as part of the training corpus.

(1) သူသည်တူဖြင့်ခေါက်ဆွဲစားသည်။
He eats the noodle with **chopsticks**.
သူ စားသည် ခေါက်ဆွဲ ဖြင့် **တူ** ။

(2) သူမှာတူသုံးယောက်ရှိသည်။
He has three **nephews**.
သူ မှာရှိသည် သုံးယောက် **တူ** ။

(3) လက်သမားသည်တူကိုသုံးသည်။
Carpenter uses the **hammer**.
လက်သမား သုံးသည် **တူ** ။

The structure of corpus for the above example sentences are shown in fig. 2. As it is clear, the Myanmar word "**တူ**" are mapped into three different English words "**chopsticks**", "**nephew**" and "**hammer**" based on its sense. From the corpus, we extract the possible English meanings of the target ambiguous word and collect data concerning each sense meaning for creating context vectors.

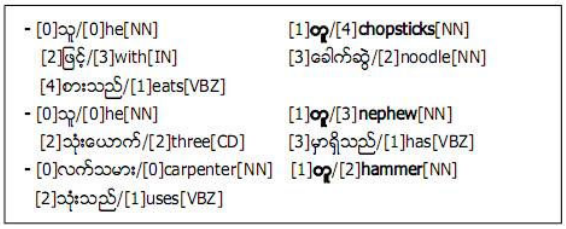

Fig.2 The Structure of Corpus

8. OVERVIEW OF THE PROPOSED SYSTEM

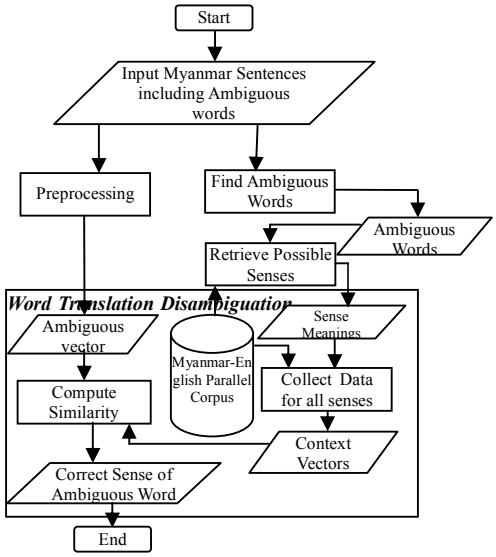

Fig.3 Proposed system Design

Fig. 3 describes overview of the proposed system. The proposed system uses the idea of the Nearest Neighbor Cosine Classifier. Firstly, the system takes Myanmar Sentences including ambiguous words as input. In the preprocessing step, the system performs word segmentation by using Myanmar word segmenter and removes stop words such as prepositions, conjunctions and particles and then the ambiguous vector is created. It also detects the ambiguous words from the input. Secondly, the system finds all possible sense meanings of the target ambiguous word from the training corpus. It also collects data concerning with each sense meaning of the ambiguous word to create context vectors. The system uses topical feature that represent co-occurring words in bag-of-word feature.

The system removes the stop words again from the context vectors and it might include the kinds of stop words such as prepositions, conjunctions and particles since they come from the training corpus. It also removes the redundant words from each context vector. The process of making ambiguous vector and context vectors is described in detail in step 1 to 3 of the proposed algorithm. Thirdly, the cosine values between ambiguous vector and each of the context vectors are calculated and the sense that is the "nearest" (largest cosine/smallest angle) is selected as a correct sense by the classifier. Finally the system generates the correct English meaning for the target ambiguous word as output. This process is described in detail in step 4 and 5 of the proposed algorithm. The proposed algorithm is shown in the following fig. 4.

Step1:Preprocessing
- -Segment input sentence
- -Remove stop words from input sentence and create ambiguous vector

Step2:Multi-sense Look-up
- -Retrieve all possible sense meanings of ambiguous word from corpus
- -Collect training data concerning each sense from corpus

Step3:Build context vectors for each sense based on collected training data
- -For all context vectors do
  - -Remove stop words
  - -Remove redundant words
- -End For

Step4:Calculate the cosines between ambiguous vector and each of the context vectors

$$\cos\ \theta = \frac{A \cdot B}{\| A \| . \| B \|} = \frac{\sum_{i=1}^{n} A_i . B_i}{\sqrt{\sum_{i=1}^{n} A_i^2} \sqrt{\sum_{i=1}^{n} B_i^2}}$$

where A represents each word in ambiguous vector
B represents each word in each context vector

Step5: Choose correct sense of the target word.

$s' = \arg\max \text{score}(s_i)$

Fig.4 Proposed algorithm for Myanmar Word Sense disambiguation

9. EXECUTION OF PROPOSED WSD ALGORITHM

We give an example of the execution of our system and we try to disambiguate the word "ကျွန်း (kjun)" in the sentence: For example, the input sentences:

(1)"ကျွန်းသည်အလွန်အသုံးဝင်သောသစ်မာဖြစ်သည်။"

(Teak is a very useful hardwood.)

(2) "ကျွန်းတွင်လူများနေထိုင်ကြသည်။"

(People live in island.)

Ambiguous word: "ကျွန်း (kjun)"

1) Preprocessing

In the preprocessing, we first segment the input sentence by using Myanmar word segmenter**.** After segmentation: we get the following sentence.

(1)"ကျွန်း_**သည်**_အလွန်_အသုံးဝင်သော_သစ်မာ_ဖြစ်သည်_".

(2) "ကျွန်း_**တွင်**_လူများ_နေထိုင်ကြသည်_".

Then, we remove all the function words (stop words). Stop words include pronouns, prepositions, conjunctions particles, etc. After removing stop words: we create an ambiguous vector. Ambiguous vector for each sentence:

(1) [အသုံးဝင်သော, အလွန်, သစ်မာ, ဖြစ်သည်].

(2) [လူများ, နေထိုင်ကြသည်]

2) Multi-sense loop up

Secondly, we find all possible English meanings of Myanmar ambiguous word from the corpus. The word "ကျွန်း (kjun)" has two senses, **teak** and **island**. The system also collects data concerning with above two senses from the training corpus.

3) Build context vectors for each sense based on collected training data

Thirdly, we construct the context vectors for each sense using the collected data. We remove stop words and redundant words from each context vector. So, we get the following two context vectors:

teak=[တံတား, အဖိုးတန်သည်, **ဖြစ်သည်**, တည်ဆောက်ထားသည်, ဆောက်လုပ်သည်, အိမ်, နေထိုင်သည်, ပြုလုပ်ထားသည်, **အလွန်**, ဆောက်လုပ်ထားသည်, မြန်မာ့, ပရိဘောဂ, **သစ်မာ**, အဖိုးတန်သော, **အသုံးဝင်သော**, ကမ္ဘာပေါ်]

island=[**လူများ**,သာယာသော, ပတ်လည်, ရေ, ဘေးတွင်, **ဖြစ်သည်**, ပေါ်တွင်, ထဲတွင်, တစ်ကျွန်း, ထင်ရှားသည်, ပင်လယ်များ, အိမ်, ပင်လယ်, ဝန်းရံထားသည်, မြန်မာနိုင်ငံ, အများအပြား, ကိုကိုး, **နေထိုင်ကြသည်**]

4) Calculate the cosines similarity

We compute the cosine similarity between the ambiguous vector and each context vector and calculate scores. The cosine value of "teak" sense is greater than the value of "island" sense for the first sentence and the cosine value of "teak" sense is smaller than the value of "island" sense for the second sentence.

5) Choose correct sense of the target word

After calculating the score of each sense, we can assign the sense with the highest similarity to the word. So, we choose "teak" for the ambiguous word "ကျွန်း (kjun)" in the first sentence and "island" for the second sentence. By the way, we can disambiguate a word with multiple senses in a given context.

10. EXPERIMENTAL RESULT

The experiments are conducted using data drawn from "Myanmar-English Parallel Corpus" which contains sentences used in various domains. Our approach relies on supervised learning. The training set consists of 1500 sentence pairs and test set contains 250 sentences. We collect 60 ambiguous nouns and 100 ambiguous verbs for experiment. We used only the pure text data, and not the speech transcriptions. The sense of the ambiguous words was obtained from the

Myanmar-English dictionary. The number of senses per test word ranges from 2 to 9 and the average was 4.

For evaluation purpose, the test sentences are divided into two groups, the first group sentences are composed of words in the corpus and the second group sentences are composed of words in the corpus but not exactly the same sentences in the corpus. There are 150 sentences in the first group and 100 sentences in the second group.

Table 3 Experimental results on test data set

Sentence Type	Accuracy (%)
Test Sentences in the training set	100%
Test Sentences are composed of words in the training sentences, but not exactly the same sentences in the training set	90%
Average	95%

Table 3 shows the results of our experiment. The experiment shows that disambiguation process by using the proposed method from the mentioned corpus, received about 95% overall accuracy in detecting the correct translation of ambiguous words. The 5% failure in disambiguation process is caused by the amount of the training corpus, the different senses of words which may exist in the data set and the problem of segmentation.

11. CONCLUSION AND FUTURE WORK

This research was the first attempt to create a word sense disambiguation system for Myanmar Language. We evaluated our approach through an experiment in nouns and verbs using the Myanmar-English parallel corpus. We ensured that the input sentence contained ambiguous word with multiple English translations. The proposed system can disambiguate senses of Myanmar ambiguous words based on Nearest Neighbor Cosine Classifier. The system achieves 95% accuracy.

The proposed method can disambiguate senses of Myanmar ambiguous words by comparing similarity. Our method is simple but effective for WSD. Our method was somewhat language independent because it used only bag-of-word feature. Syntactic and collocation features may be useful to improve the performance of our method. We would like to implement this system for words with other part of speech such as 'Adjective' and 'Adverb'. Our plan also is to use this work in the areas that must have word sense disambiguation algorithm before it such as information retrieval, grammatical analysis, speech processing, text processing, and will continue trying to apply our method to other languages by studying language characteristics. Hence, our proposed method of disambiguation senses can be considered to be useful and applicable for other research efforts in natural language processing.

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